West, Williams & Saxtons Rivers & Lower Connecticut River
Basin 11
Tactical Basin Plan

JULY 2021 | Public Comment DRAFT

Tactical Basin Plan was prepared in accordance with 10 VSA § 1253(d), the Vermont Water Quality Standards[1], the Federal Clean Water Act and 40 CFR 130.6, and the Vermont Surface Water Management Strategy.

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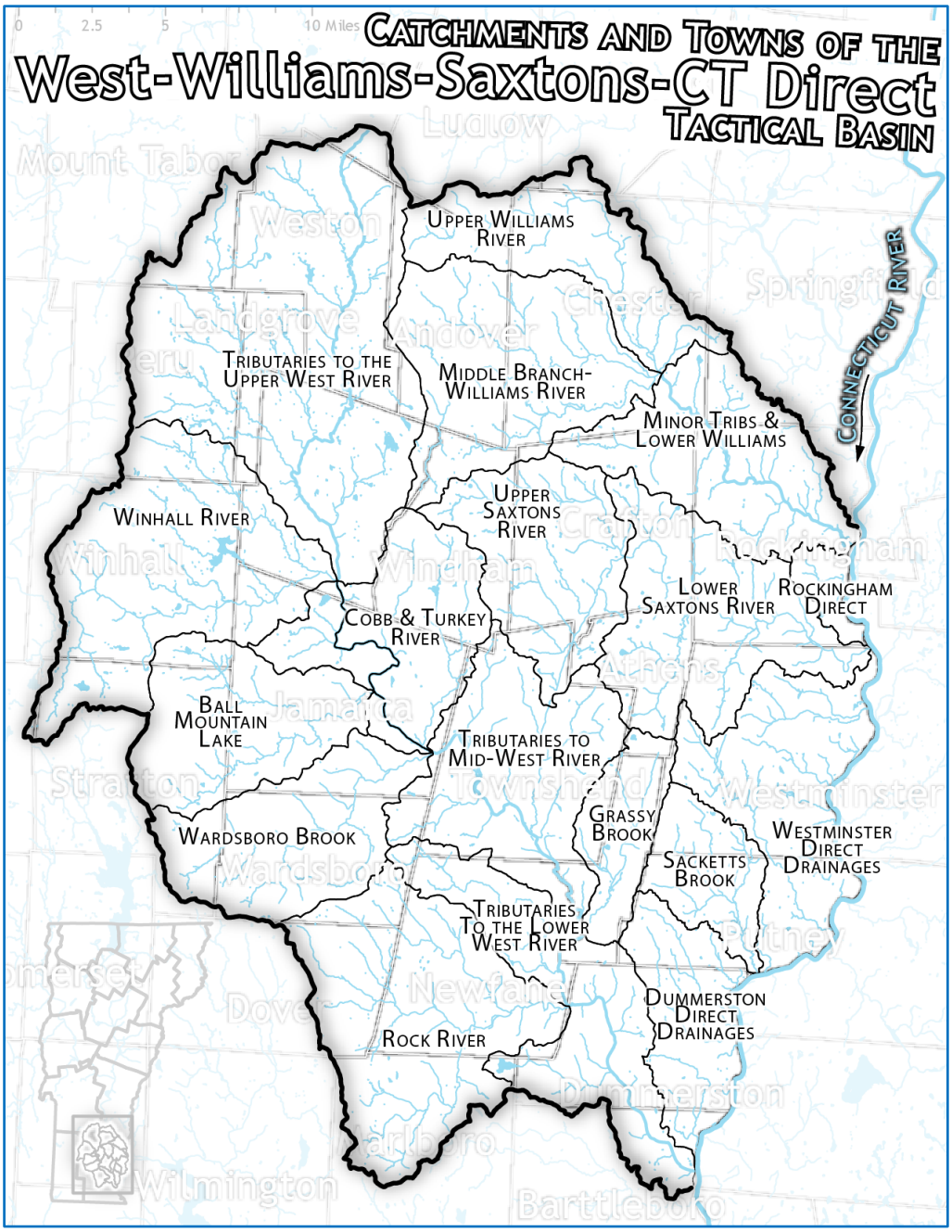
Cover Photo: Marie Levesque Caduto, West River, Dummerston VT

Towns in Basin 11 - 13

Andover	Dummerston	Mount Holly*	Stratton
Athens	Grafton	Mount Tabor	Townshend
Brattleboro	Jamaica	Newfane	Wardsboro
Brookline	Landgrove	Peru	Westminster
Cavendish*	Londonderry	Putney	Windham
Chester	Ludlow*	Rockingham	Winhall
Dover	Marlboro		

* - towns with small areas in the watershed



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Connecticut - Kwanitekw - Long River
West River - Wantastekw - Lost River

Executive Summary

Covering over 600 square miles of southeastern Vermont and encompassing twenty-nine towns, the West, Williams, Saxtons River Basin (Basin 11) and the adjacent Connecticut River drainages are mostly forested with dispersed agriculture and development focused around the mainstem of the Connecticut and larger tributaries and in the upland ski resort areas. This heavy forest cover provides clean water downstream filling the Basin with high quality water. Opportunities for reclassification of waters are abundant. Forty-four waters may meet or exceed A(1) or B(1) criteria for one or more designated uses and ten are candidates for consideration as Outstanding Resource Waters (Table 8).

There is reason to be optimistic about current conditions, but a changing climate and development pressure may impact water quality in the Basin into the future.Increases in precipitation events, rising temperatures and growth in residential and recreational development increasingly require watershed restoration projects to preserve the natural ecological services the Basin offers.

Water quality impacts track closely with the non-forested land uses (Figure 23). Agriculture and development along the Connecticut River floodplain, development in Bellows Falls/Westminster, and Brattleboro, and the Stratton and Bromley resort regions all show impacts to water quality.

Priority restoration work includes riparian and floodplain restoration, sediment attenuation, stormwater and non-point source runoff control, and habitat improvement. Watershed protection to maintain ecosystem function and resilience are also crucial.

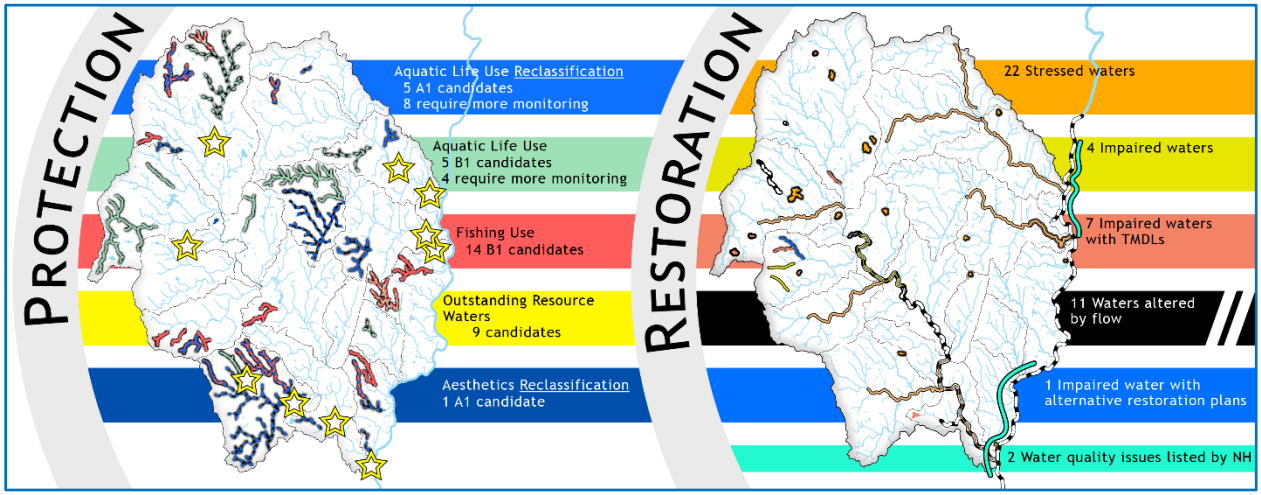


Figure 1. Surface Waters Prioritized for Protection and Restoration

Residents and visitors alike value the uses of the Basin's rivers and lakes, enjoying flatwater and white-water boating, trout and bass fishing and abundant swimming locations in the rivers, streams

and lakes. However, limited access to recreational areas has been identified as a regional concern, which has been exacerbated by increased outdoor activity during the COVID-19 pandemic.

The Basin also hosts a high concentration of rare, threatened and endangered species, due in part to being at the northern range of numerous southern species. This region is identified as a critical travel corridor for wildlife movement due to the impacts of climate change, making protection of this migration route a priority.

Despite the overall high quality of the Basin's waters, 43 are listed as impaired, altered or stressed for one or more pollutants. Acid precipitation and pH issues are most frequent, followed by flow alterations, temperature and sediment issues (Table 11). Total Maximum Daily Loads have been developed for acid impaired lakes, for *E. coli* bacteria in the West River and for dissolved oxygen/nitrogen in the Connecticut River and Long Island Sound.

Targeting restoration and protection strategies to the land use sectors of agriculture, developed lands, wastewater and natural resources provides a framework for basin plan implementation focused on the sources of pollutants. Projects prioritized for implementation over the upcoming five years range from land protection through river corridor easements and acquisition, to stormwater and river corridor planning, to floodplain restoration and dam removals. Almost 100 strategies are put forth in this plan while over 250 potential projects are listed in the Watershed Project Database at the time of this plan's development.

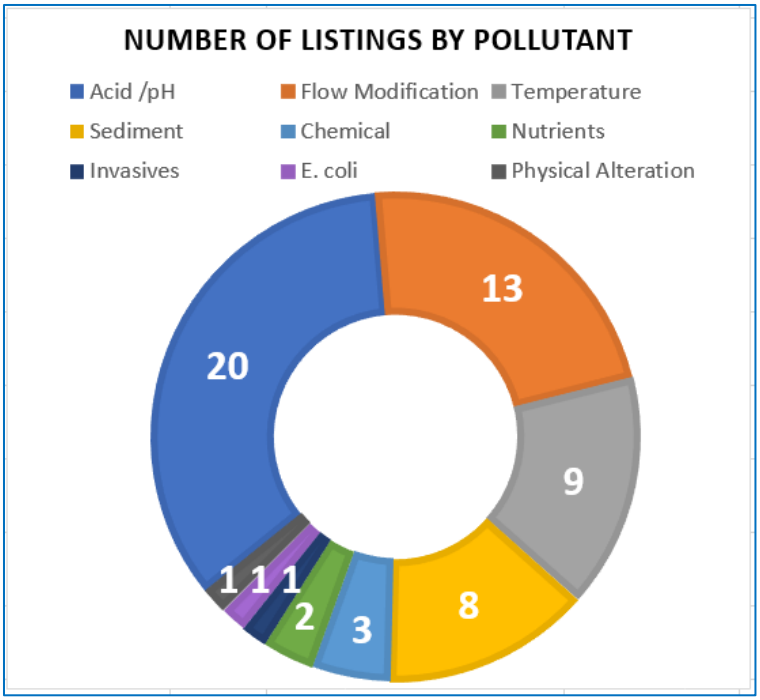


Figure 2. Priority Listings by Pollutant

These projects expand on the 58 projects implemented from the 2015 Plan.

Priority strategies for this Plan, shown in Table 1, are targeted to specific water quality concerns indentified through this planning process. These and the projects in the Implementation Table (Table 20) in Chapter 5 will be the focus of Plan implementation going forward.

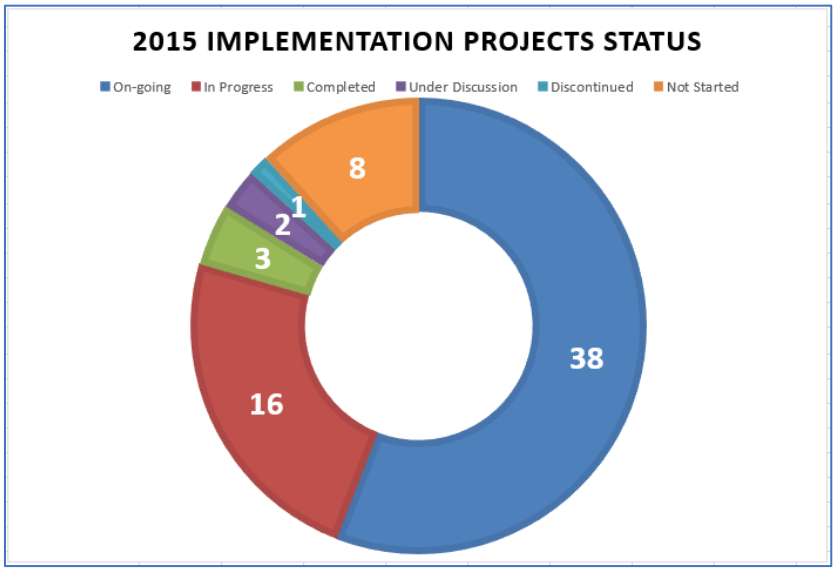


Figure 3. 2015 Implementation Projects Status

On-going projects are longer-term efforts that are continuing throughout the implementation phase of the Plan. Projects that are In-Process are discrete projects that have been started but not yet completed.

Table 1. Focus Areas and Priority Strategies for Restoration and Protection

Focus Area	Priority Strategies
AGRICULTURAL LANDS	
Williams River, lower Saxtons River, upper West River	Address sediment, nutrients and temperature issues through additional technical assistance targeted to new farmers and small farms and increasing implementation of riparian buffers and farmyard practices.
DEVELOPED LANDS / STORMWATER	
Brattleboro, Bellows Falls/No. Westminster, Stratton/Winhall, Chester	Conduct stormwater master planning to identify and prioritize actions and implement High Priority projects
Brattleboro, Dummerston	Implement Crosby Brook SWMP
DEVELOPED LANDS / ROADS	
Upper West River in Weston, Ball Mountain Brook; Marlboro Branch and Townshend in the West River watershed; the Middle and South Branches Williams River; Grafton in the Saxtons River Watershed; and Morse (Westminster) and Sacketts (Putney) in the Connecticut Direct drainage	Implement priority practices identified in Road Erosion Inventories in target watersheds
WASTEWATER	
Weston, Londonderry, Jamaica, Grafton, Townshend, Newfane	Conduct wastewater planning and feasibility studies for small communities without municipal systems
NATURAL RESOURCE RESTORATION: Rivers, Lakes, Wetlands & Forests	
RIVERS:	
Lower Williams and lower Saxtons Rivers, Crosby Brook	Address sediment and/or nutrient issues causing Stressed and Impaired listings
Lower Sacketts Brook	Identify and address sources of bacteria
Upper West River	Complete a geomorphic assessment and River Corridor Plan for the upper West River
Westminster > Blake-Higgens Dam Londonderry > Williams Dam	Remove dams, esp. High Hazard dams

Focus Area	Priority Strategies
LAKES:	
Wantastiquet Lake, Cole Pond, Sunset Lake	Promote & Implement the Lake Wise Program to encourage lake-friendly shoreline property maintenance
Lowell Lake, Gale Meadows, Kenny Pond, Sunset Lake	Establish Lay Lake Monitoring on appropriate lakes and ponds
Gale Meadows Pond (the only lake in the Basin with a known population of Eurasian watermilfoil); Lowell Lake and Townshend Reservoir (to help prevent further spread)	Establish a boat access Greeter Program
WETLANDS:	
Agricultural fields along Rt 100 north of village - Weston	Assess areas of prior converted wetland and hydric soils for restoration
Herricks Cover - Rockingham; Henwood Hill Road Marsh - Westminster; Retreat Meadows - Brattleboro; Sand Hill Road - Putney	Implement wetland restoration as sites and opportunities are identified
FISHERY:	
Baker Brook, Dover Brook, Fair Brook, Farnum Brook, Greendale Brook, Pike Hollow Brook, Rock River, Utley Brook, Waite Brook, Andover Branch, Canoe Brook, East Putney Brook, Morse Brook, and Salmon Brook.	Identify and designate B1 High Quality Fishing
Basin-wide, Herricks Cove, Retreat Meadows	Control current and prevent future introductions of these exotic species and pathogens to protect healthy fisheries
HAZARD MITIGATION & FLOOD RESILIENCY	
Basin-wide	Work with municipalities to adopt floodplain and river corridor protections to achieve greater ERAF funding levels
Basin-wide	Work with municipalities to complete Hazard Mitigation Plans and Emergency Management Plans
Middle Branch Williams River, Saxtons River	Prioritize hazard mitigation and corridor protection projects on the Middle Branch Williams River and the Saxtons River

What is a Tactical Basin Plan?

A Tactical Basin Plan (TBP) is the strategic guidebook produced by the Vermont Agency of Natural Resources (VANR) to protect and restore Vermont's surface waters.

Tactical basin planning is carried out by the Water Investment Division (WID) of the Vermont Department of Environmental Conservation (VDEC) in collaboration with the Watershed Management Division (WSMD) and in coordination with other state agencies and watershed partners. Tactical basin plans (TBPs) are integral to meeting a broad array of both state and federal requirements (Figure 4), including the U.S Environmental Protection Agency's (EPA) 9-element framework for watershed plans[1] and state statutory obligations including those of the Vermont Clean Water Act, and Act 76 of 2019 and 10 V.S.A. § 1253.

Figure 4. Requirements of Tactical Basin Plans

Figure 5. Steps in the 5-year Basin Planning Process

Basin-specific water quality goals, objectives, strategies, and projects described in the TBPs aim to protect the ecological health of Vermont waters and public health and safety and ensure public use and enjoyment of these as set forth in the Vermont Surface Water Management Strategy (VSWMS) and the Vermont Water Quality Standards (VWQS), and as identified in mandated water quality clean-up plans. The TBP process (Figure 5) allows for the issuance of plans for each of Vermont's fifteen basins every five years, as required by statute 10 V.S.A. § 1253.

The basin planning process includes:

- Monitoring water quality as described in the Water Quality Monitoring Program Strategy;

[1] Environmental Protection Agency, 2008

- Assessing and analyzing water quality data;
- Identifying strategies and projects to protect and restore waters;
- Gathering and addressing public input for finalizing the plan; and
- Implementing and tracking plan priorities.

Chapters 1-4 provide an overview of the basin, protection and restoration priorities and efforts to protect and restore water quality for each land use sector. Together these support the targeted strategies listed in the implementation table in Chapter 5. (Table 20)

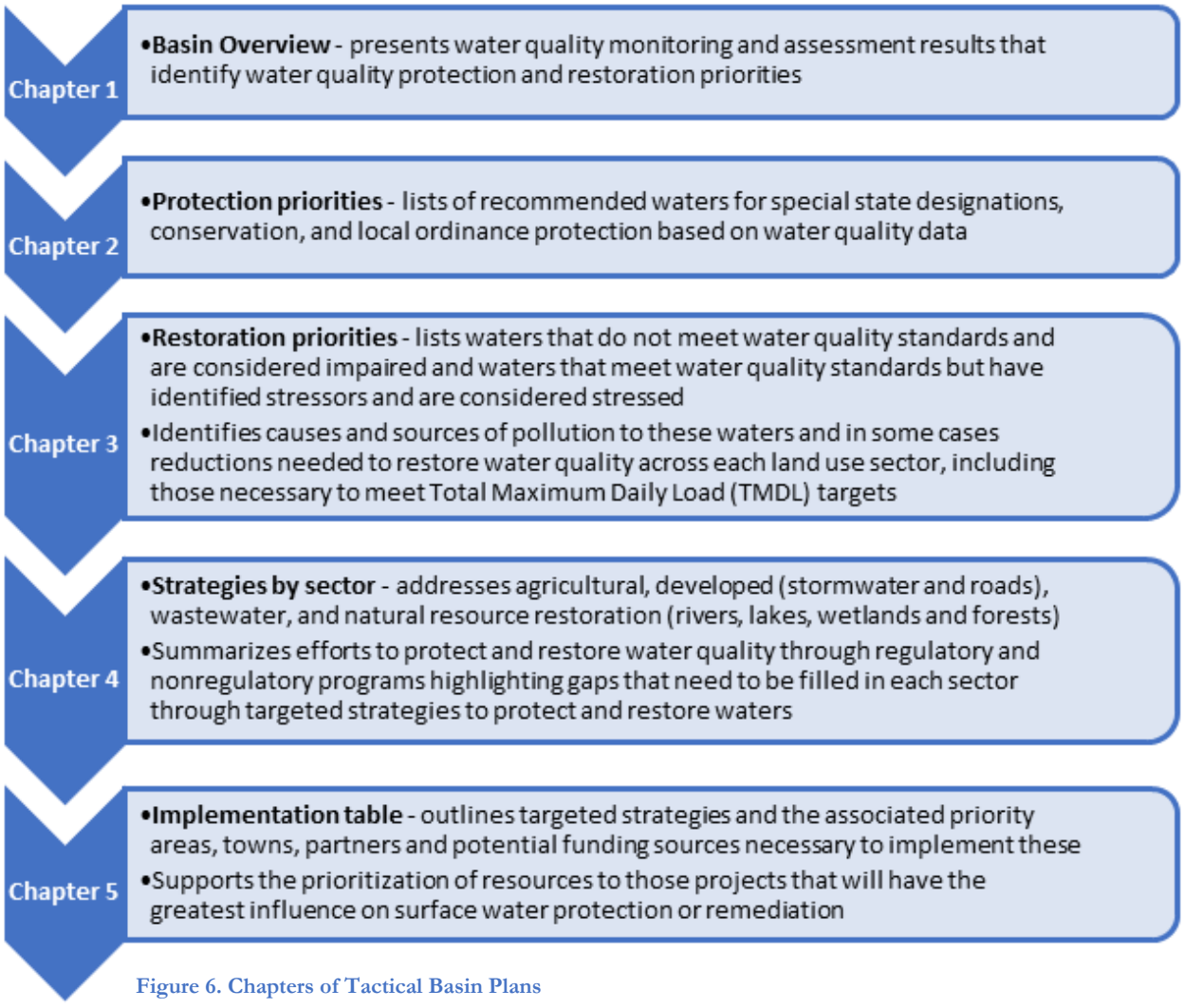


Figure 6. Chapters of Tactical Basin Plans

Tactical basin plans build on earlier planning efforts as shown in the Report Card located in Appendix A which provides a status update for each of the objectives identified in the previous basin plan. These strategies target individual projects that are tracked via its online counterpart, the Watershed Projects Database (WPD). The WPD is found on VANR's Clean Water Portal and is

continuously updated to capture project information from the TBP process, on the ground assessments, and emerging projects due to natural and anthropogenic events. VANR's Clean Water Portal is an online platform that houses a variety of clean water tools to assist with project planning, searching existing projects, funding opportunities, and more. The Clean Water Portal links to the Annual Performance Report that outlines progress in implementing clean water practices for each basin in Appendix A and the clean water dashboard that provides funding levels for each basin.

Many partners are integral to the planning process, these include:

- Connecticut River Joint Commissions and Wantastiquet and Mount Ascutney Local River Subcommittees
- Connecticut River Conservancy
- Municipalities throughout the Basin
- Saxtons River Watershed Collaborative
- Southeastern Vermont Watershed Alliance
- Mount Ascutney Regional Commission
- Trout Unlimited & Local Chapters
- US Army Corps of Engineers
- USDA
    - Forest Service and Green Mountain National Forest
    - Natural Resources Conservation Service
- VT Agency of Agriculture, Food and Markets
- VT Agency of Natural Resources Departments of
    - Environmental Conservation
    - Fish and Wildlife
    - Forests, Parks and Recreation
- VT Agency of Transportation
- Windham County Natural Resources Conservation District
- Windham Regional Commission

Chapter 1 – Basin Description and Conditions

A. Basin 11 Watershed Overview

From the headwaters of South Mountain in Mount Holly, and framed by Bromley, Stratton, and Hogback Mountains on the west and the Connecticut River on the east, Basin 11 runs from the crest of the southern Green Mountains almost to the Massachusetts line, dropping over 3700' in elevation from the high point in Stratton to its lowest point in Brattleboro. The Basin covers over 600 square miles and encompasses twenty-nine towns in full or in part.

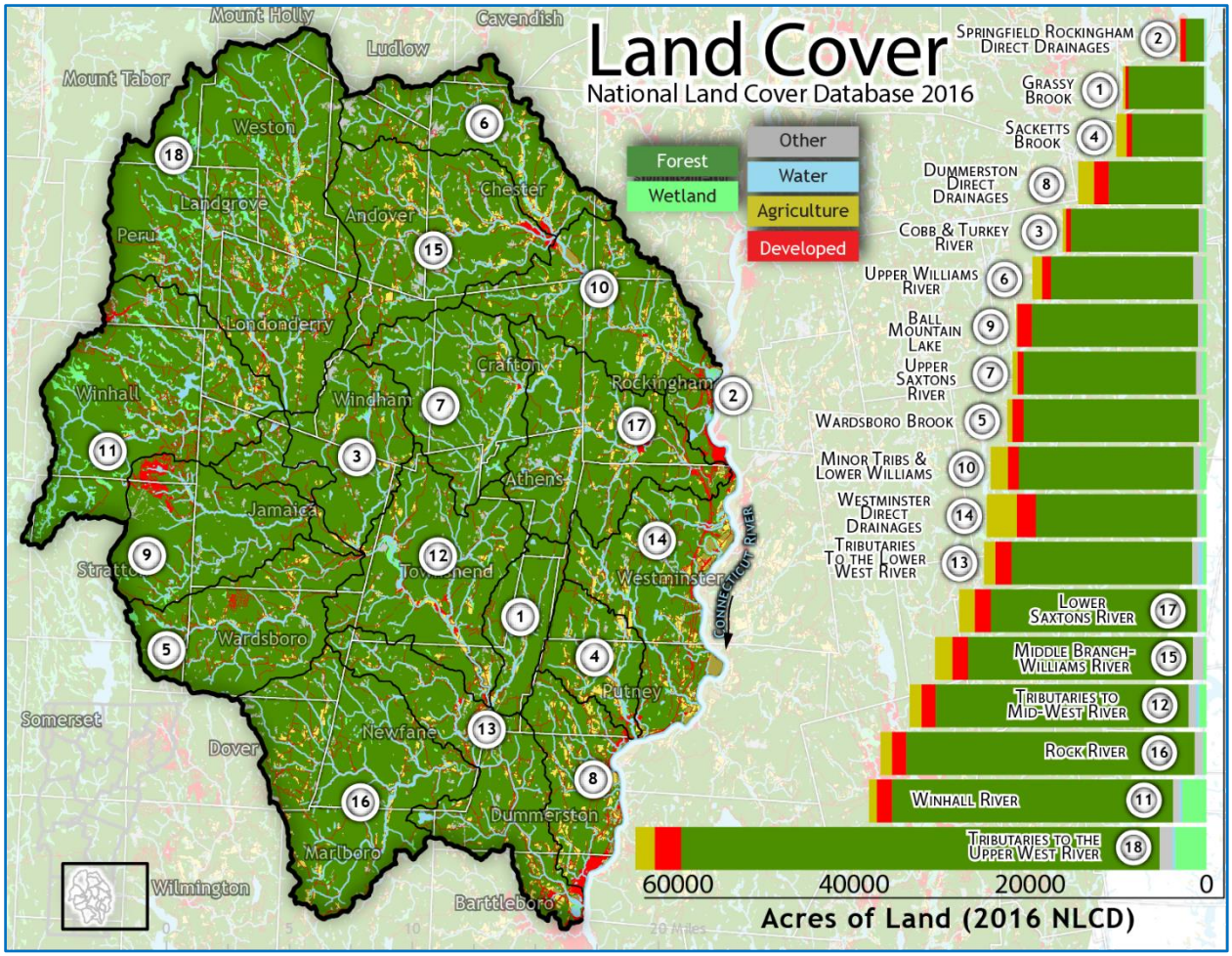


Figure 7. Land Use Cover

The largest of the major watersheds in the Basin is the West River draining 423 square miles flowing from Weston to Brattleboro. Its larger tributaries include the Rock and Winhall Rivers and Wardsboro and Ball Mountain Brooks. Utley, Flood, Cobb, Turkey Mountain and Grassy Brooks are also in this watershed.

The Williams River flows from the hills of Andover down to Herricks Cove in Rockingham drains 117 square miles. The mainstem of the Williams runs along Route 103, while the Middle Branch flows beside Route 11.

The Saxtons River drains 78 squares miles coursing from Windham to Westminster. Its two main tributaries, Bull Creek and the South Branch, flow in from the south.

Approximately 26 miles of the Connecticut River mainstem are also covered in this basin. The reach extends from Herricks Cove in Rockingham to the Retreat Meadows in Brattleboro. Both of these extensive wetlands are created by the backwater from hydroelectric dams on the Connecticut River. The largest brooks feeding directly into the Connecticut River are East Putney and Sacketts Brooks both of which are in Westminster and Putney. Other brooks in this reach include Commissary, Morse, Mill, Fullam, Chase, Canoe, Salmon and Crosby Brooks and many smaller unnamed streams.

There are 49 lakes, ponds, and reservoirs in the Basin covering 1,030 acres. Gale Meadows Pond (195 acres), Lowell Lake (109 acres), Townshend Reservoir (108 acres) and Ball Mountain Reservoir (85 acres) are the largest. All of these are in the West River watershed and all four have dams that create impoundments or increase water levels.

Land cover greatly influences the quality of the water resources nearby and downstream (Figure 7 and Table 2). The extent of forest cover and the limited areas of development and agriculture are protective of water quality in the Basin.

Table 2. Percent land use for the Basin

Forest	Developed	Agriculture	Wetland	Water	Other
83.6	5.6	5.0	2.8	0.5	2.5

B. Climate Change Implications

Climate change is altering rain and snowfall patterns in Vermont. Precipitation is coming in shorter but more intense storms causing more water running through streams and rivers at higher velocity. Air and water temperatures are warming and there are increasing periods of drought. Development and loss of wetlands is preventing water from seeping into the ground to recharge groundwater and land clearing along shorelines is reducing tree cover that keeps water cool. With a warmer, wetter climate and more extreme precipitation events, flooding and erosion concerns are likely to become more pressing. [2,3]

[2] Climate Change in Vermont
[3] Climate Change and Vermont's Waters

Protecting our waters from climate change means protecting the natural processes that keep them healthy. Giving streams and rivers space to move will reduce erosion rates, increase storage of floodwaters and allow for natural sediment deposition that rebuilds nutrient-rich floodplains.

These trends are projected to continue across most of the United States, and particularly in the Northeast and Midwest. In the Northeast the amount of precipitation falling in the heaviest 1% of storms [4] is projected to increase to 55% of storm events. These changes could have critical consequences for hydrology, water quality and availability, ecological integrity and human infrastructure.[5]

Data from NOAA's Climate at a Glance[6] tool show the increase in precipitation in Windham County over time. Ranging from the annual low of 34.8 inches in 1964 to the high 68.4 inches in 2011, the year of Tropical Storm Irene, the trend reveals an increase of 0.73 inches per decade over the 125 years of collected data. Figure 8. This is the second highest increase of the 14 counties in the state.

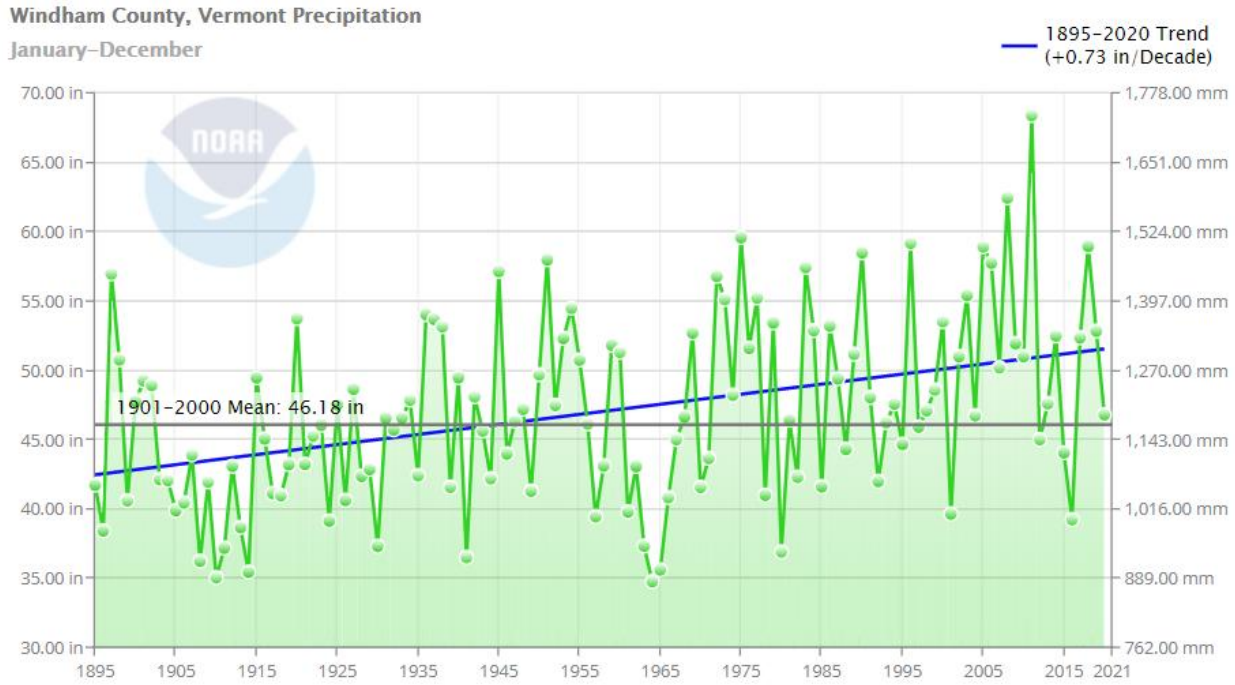


Figure 8. Annual Precipitation in Windham County 1895 - 2020

[4] FOURTH NATIONAL CLIMATE ASSESSMENT, CHAPTER 2: OUR CHANGING CLIMATE, Figure 2.6 Observed and Projected Change in Heavy Precipitation, https://nca2018.globalchange.gov/chapter/2/#fig-2-6

[5] Climate Change and Vermont's Waters

[6] NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published February 2021, retrieved on February 11, 2021 from https://www.ncdc.noaa.gov/cag/

Local precipitation analysis indicates that Vermont follows these trends with increased rainfall from intense, local storms that drop high volumes of rainfall in short durations. Due to the surrounding terrain, consisting of steep slopes and narrow river valleys, the mainstem of the West, Rock and Williams Rivers, the upper Saxtons River and South Branch, Ball Mountain and Wardsboro Brooks, are especially vulnerable to flooding due to increased precipitation.

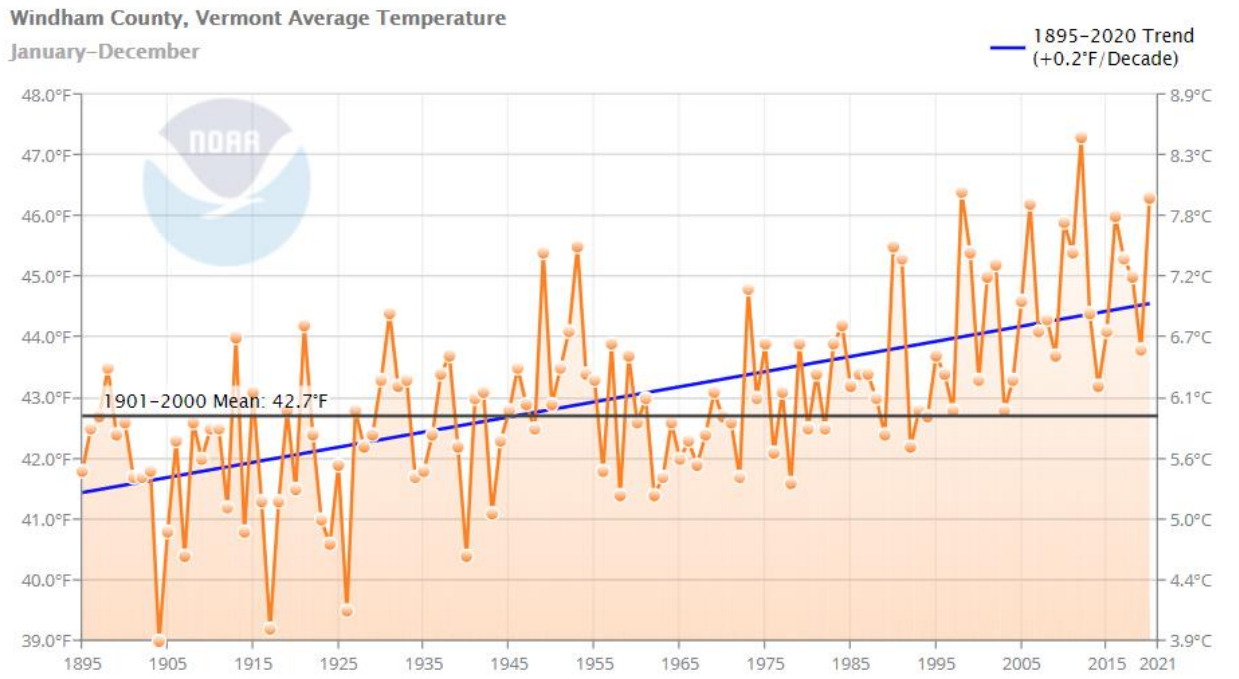


Figure 9. Average Annual Air Temperature in Windham County 1895 - 2020

A similar pattern in the average annual air temperature for the county documents a rise of 2^{O}F per decade. Figure 9.

The gradual increase in annual average temperature from ~41.5 ^{O}F in 1895 to 44.5 ^{O}F in 2020 has implications for everything from the intensity and water-carrying capacity of severe storms to agricultural viability and ski industry success to increasing droughts and wildfires.[7]

Water quality impacts from these accumulated climate changes in precipitation and air temperature include:

- Increased fluvial erosion threatening life and property from increased flow velocity and volume
- Increased nutrient and sediment inputs due to increased erosion potentially leading to increased algal blooms from the high nutrient content

[7] NOAA National Centers for Environmental information, Climate at a Glance: Global Mapping, published February 2021, retrieved on February 12, 2021 from https://www.ncdc.noaa.gov/cag/

- Increased stormwater runoff can carry pollutants into rivers and lakes
- Accelerate the decline of freshwater biodiversity already under stress from land use changes[8]
- Decreased coldwater fish populations such as trout due to excessively increasingly warm water temperatures
- Decreased fish and macroinvertebrate habitat due to sediment deposition

Changes in climate require watershed restoration projects to preserve natural sediment attenuation locations and incorporate stormwater and non-point source runoff controls to counteract pollutant transport as well as consider the potential for higher peak flows. Restoring floodplain connectivity along streams is essential to provide space for sediment, debris, and nutrients to settle and store naturally and to maintain ecosystem resilience as the climate changes. Maintaining habitat connectivity, river and lake riparian buffers, and stream equilibrium conditions will help reduce the impacts of climate change on Vermont's rivers, lakes and ponds, and wetlands.

Based on the studies reviewed by Antioch New England CSI program, land use and development decisions can and will have a profound impact on surface water resources with the potential to exacerbate or mitigate the effects of climate change and protect watershed health. Interdisciplinary and participatory processes can help communities evaluate different scenarios for land use, development, and climate change to identify shared values among a changing demographic, preferred ecosystem services, and to inform land use and planning decisions.[9]

C. Water Quality Conditions in the Basin

There is a wide variety of water quality monitoring and assessment work that is supported by VDEC and its partners which are described in detail in the Water Quality Monitoring Program Strategy[10]. The results of this work offer a snapshot of the condition of a Basin's waters. Monitoring programs in this basin include the Ambient Biomonitoring Network (ABN) that focuses on biological monitoring of macroinvertebrate and fish communities, plus targeted water chemistry and temperature monitoring. Biomonitoring staff also support the LaRosa Partnership Program which is a volunteer water quality monitoring program. The Southeastern Vermont Watershed Alliance[11] participates in LPP by sampling streams throughout this Basin and conducting targeted monitoring for pollutant tracking.

[8] Emergency Recovery Plan could halt catastrophic collapse in world's freshwater biodiversity
[9] Corvis, J. and Sylvia, M. (2021, April). Assessing the Migration System of New Hampshire and Vermont's Connecticut River Valley: Part II - Impacts on Ecology and Social Systems from Human Migration and Public Desire. *The Center for Climate Preparedness and Community Resilience.*
[10] https://dec.vermont.gov/watershed/map/monitor
[11] https://www.sevwa.org/

The VDEC Rivers Program supports stream geomorphic assessments that evaluate geomorphic and physical habitat conditions of rivers. The Lakes and Ponds Program[12] supports the Spring Phosphorus and Lay Monitoring Programs, which evaluate nutrient conditions and trends on lakes, as well as shoreland condition, and more in-depth lake assessments in addition to surveys for aquatic invasive species. Additionally, the Wetlands Program[13] conducts biological assessments on the functions and values of wetlands.

The Vermont Fish and Wildlife Department (VFWD) conducts fishery assessments and temperature monitoring to understand recreational fish populations and evaluates streams for strategic wood addition to restore habitat.

Finally, a network of streamflow gages is funded and operated in partnership among VDEC, Vermont Agency of Transportation (VAOT) and Vermont Department of Public Safety (VDPS).

All of these data are analyzed to compile the basin water quality assessment reflected in a series of maps and data tables that are summarized here.

[12] https://dec.vermont.gov/watershed/lakes-ponds
[13] https://dec.vermont.gov/watershed/wetlands

Condition of Rivers and Streams

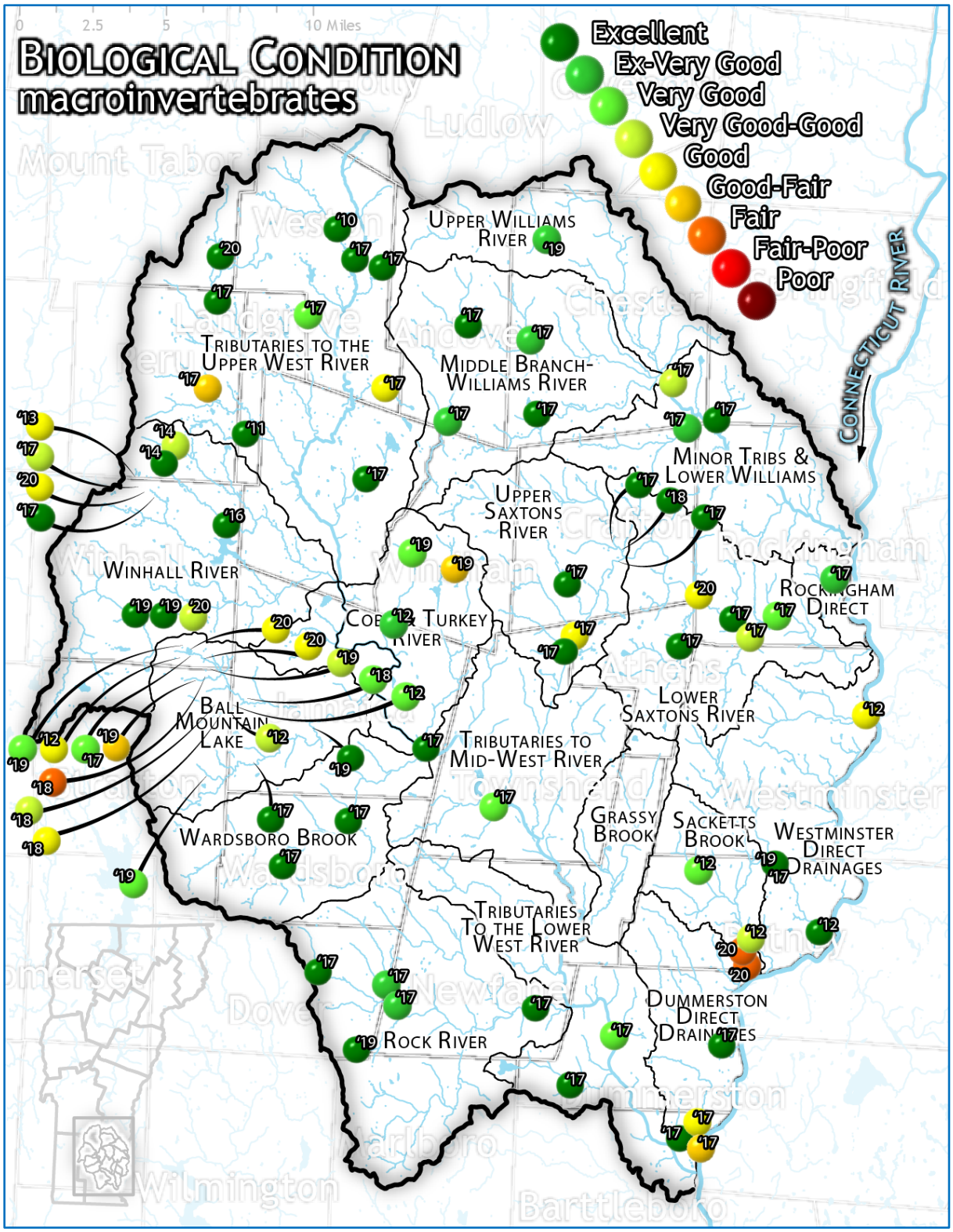


Figure 10. Biological Condition of Macroinvertebrate Community

Bioassessment on Streams

The Watershed Management Division (WSMD) in VDEC assesses the health of a waterbody using an integrated aquatic biota assessment of aquatic macroinvertebrates and fish communities based on in-stream physical, chemical and biological conditions over space and time. These assessments determine if streams meet the VWQS expectations for the aquatic biota use. This is described in the Vermont Water Quality Monitoring Program Strategy 2011-2020 which was updated in 2015. Most of these data can be accessed through the Vermont Integrated Watershed Information System (IWIS) online data portal. Each community of macroinvertebrates and fish is scored from *Excellent* to *Poor* based on stream type. If a stream repeatedly fails to meet expectations, it is a candidate for the stressed or impaired waters list.

VDEC uses a 5-year rotational monitoring approach which means that Basin 11 stream sites are typically monitored only once every 5 years. VDEC maintains 12 sentinel sites statewide which are monitored every year, including a site on the Winhall River in Basin 11. These sentinel sites are located in areas that have negligible prospects for development or land use change and are closely monitored to isolate long term impacts related to climate change.

A total of 68 macroinvertebrate assessments were completed between 2016 and 2020 at 64 sites. Results of these assessments are described below. In addition, to ensure a comprehensive understanding of water quality basin wide, data gaps are being addressed over time and sites without current monitoring data will be prioritized for the next monitoring rotation cycle. These can be found in Chapter 5 in the Monitoring and Assessment Table (Table 21).

From the most recent assessment, 41 streams (60%) exhibited *Excellent* condition meaning at reference or natural condition. 19 streams (28%) are ranked as *Very Good* or *Good*. Three brooks are in *Good-Fair* condition. Some reaches of Styles Brook in Stratton shows Good-Fair to Fair condition, while the lower reaches of Sacketts Brook in Putney are in Fair condition.

Fish Monitoring Results

Twenty-five individual sites were fully assessed for fish community from 2017 through 2020. In order for a community to be assessed there must be at least two native species present, therefore, six additional sites were unable to be assessed because Brook Trout were the only species present. Two additional sites were not assessable due to wetlands upstream, limiting the applicability of the established Index of Biotic Integrity (IBI).

Of the 30 individual samplings (several sites were sampled in multiple locations or multiple years) nine exhibited fish communities in *Excellent* condition and six sampling sites exhibited fish communities in *Very Good* condition which indicate the fish communities at these sites exceed VWQS. Seven sampling sites exhibited fish communities in *Good* condition. The condition of three are rated *Fair* and five *Poor*. More information about the results of these sampling sites and events can be found in the Vermont Integrated Watershed Information System (IWIS).

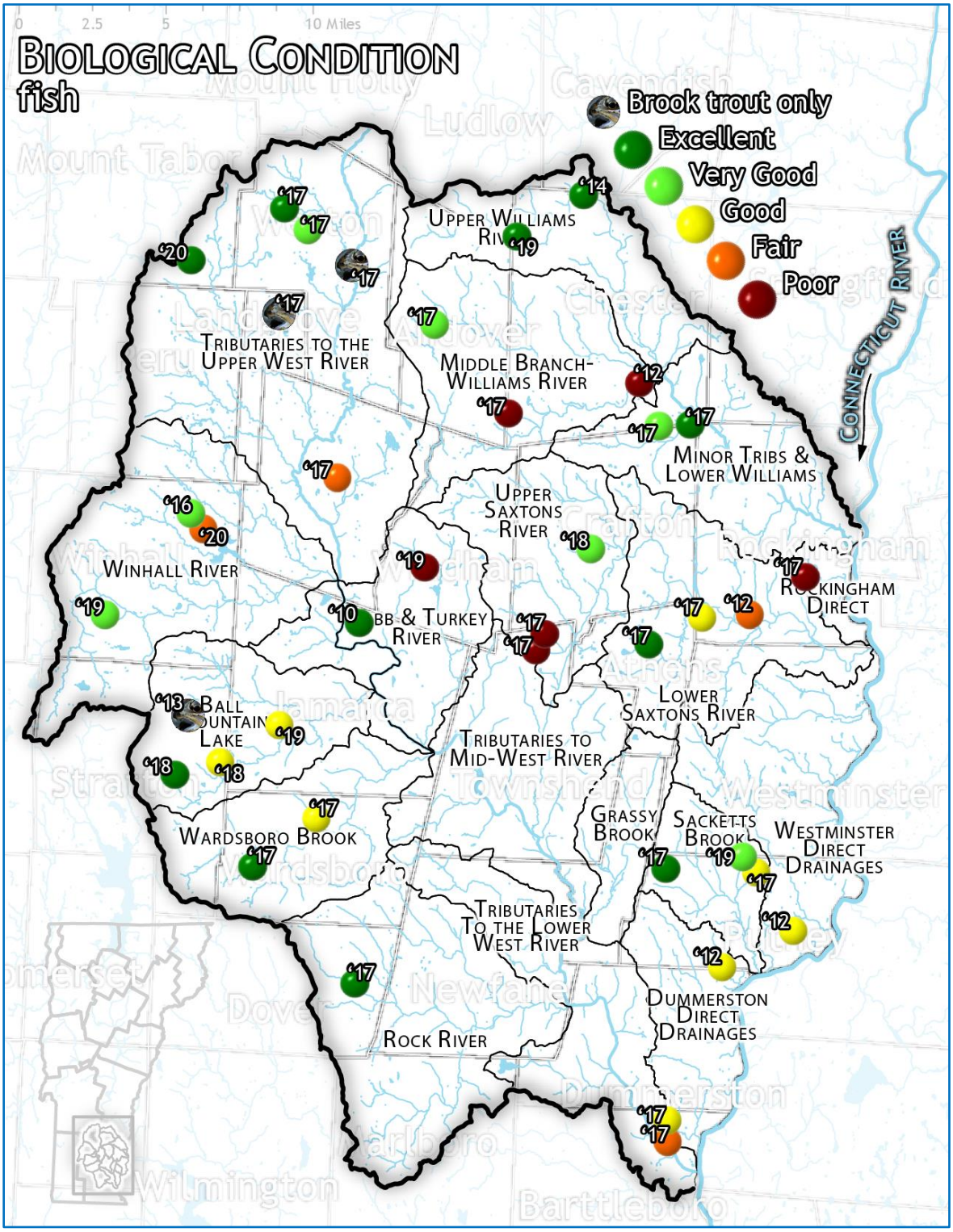


Figure 11. Biological Condition of Fish Community

Stream Geomorphic Assessments

There is limited coverage of Phase II Stream Geomorphic Assessments (SGAs) in the Basin (Figure 12). With the exception of the floodplains along the Connecticut River and the lower reaches of the West River, the majority of the Basin's rivers and streams run in steep confined valleys that are sensitive to geomorphic changes. The poor conditions along the Williams and Winhall Rivers and Wardsboro Brook reflect the impacts of Tropical Storm Irene which caused extensive flooding, damage in 2011. This storm likely exacerbated the poor conditions on the remaining watersheds that were assessed before 2011.

The upper West River will be assessed on 2021-2022 as part of this plan.

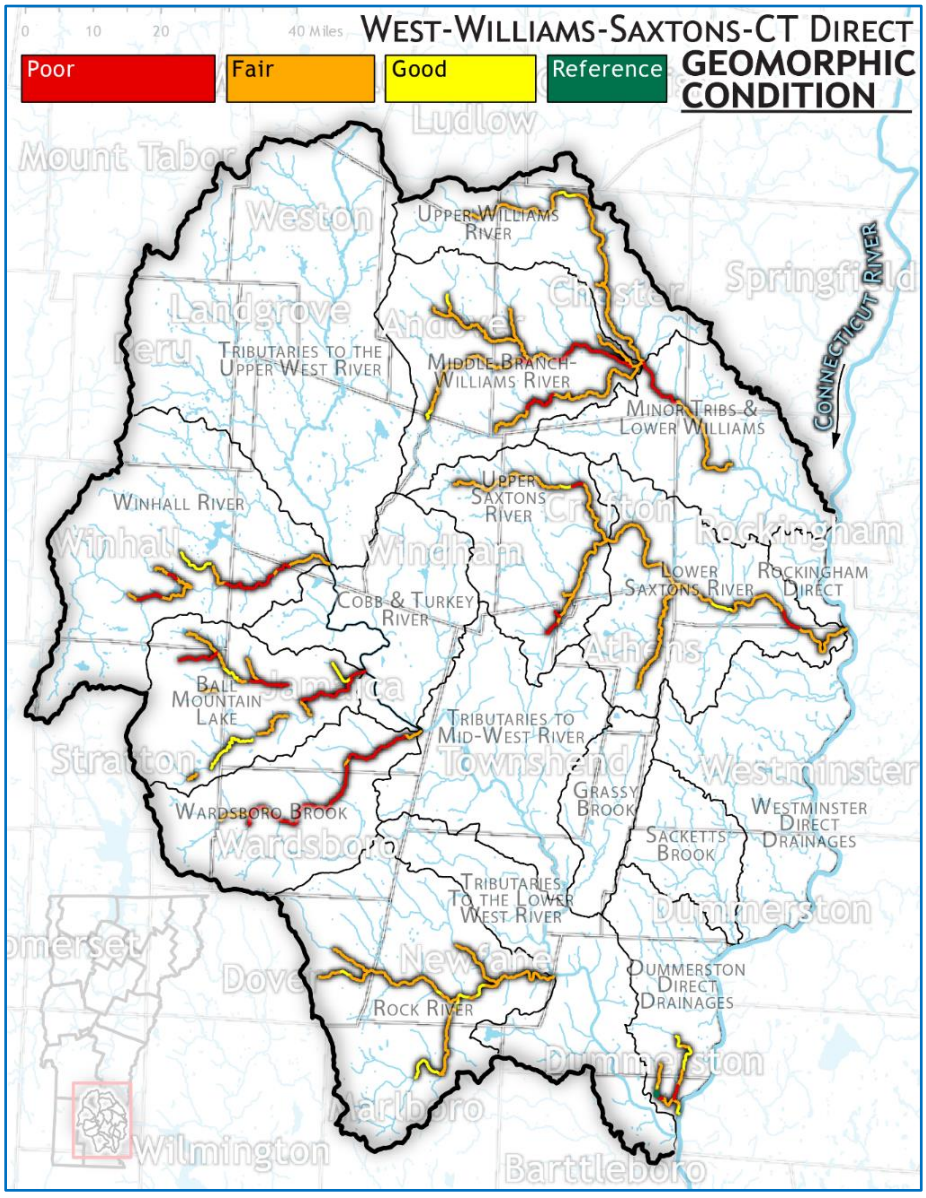


Figure 12. Geomorphic Condition of Assessed Rivers and Streams

Geomorphic conditions closely track habitat conditions. Areas with a lack of riparian buffers along rivers and streams, shown in tan in Figure 13, correlates with areas assessed as Poor geomophically. The darker shaded areas have a higher percentage of the riparian area with vegetated buffer coverage. The lighter areas indicate agricultural fields, development and roads where there is less buffer coverage.

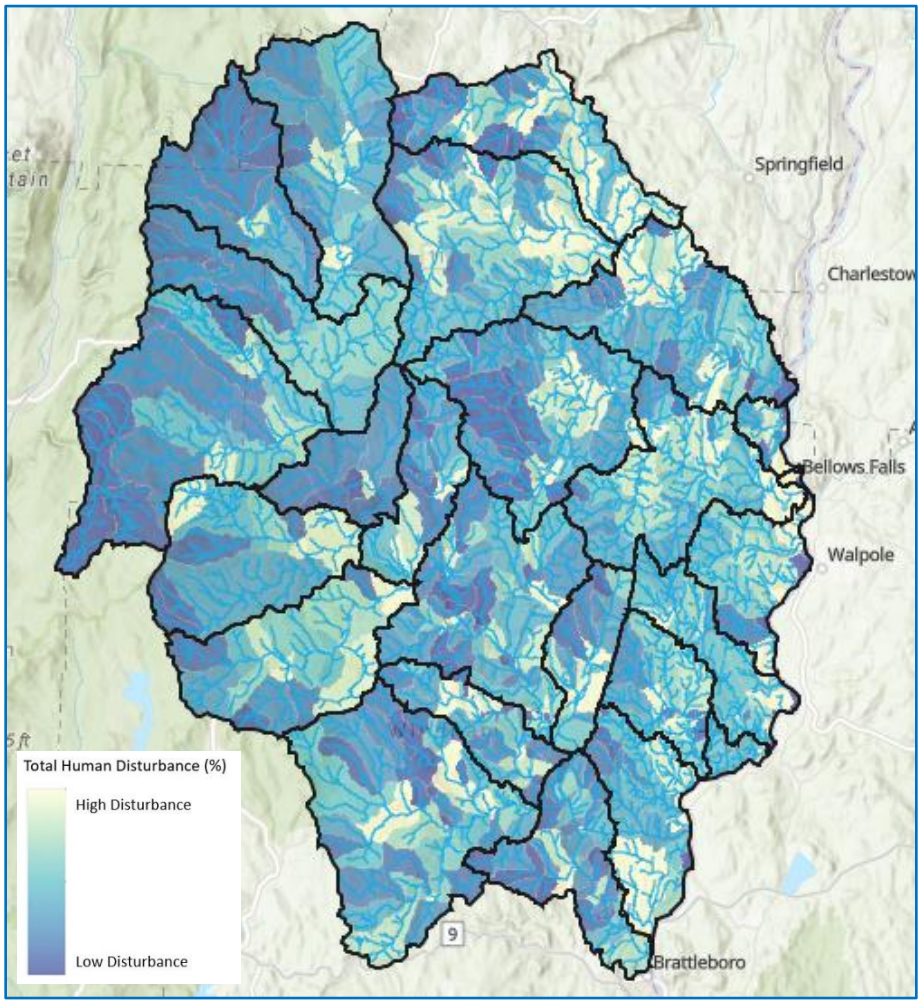


Figure 13. Percent of agriculture + developed land within the 30m riparian corridor based on land use data

Condition of Lakes and Ponds

There are 49 lakes, ponds and reservoirs in the Basin, 23 of which are over 10 acres in size and are monitored regularly by the Lakes & Ponds Program. The four largest - Gale Meadows Pond (195 acres), Lowell Lake (109 acres), Townshend Reservoir (108 acres) and Ball Mountain Reservoir (85 acres) account for almost half of the total lake acres in the basin.

Lake and pond water quality and habitat conditions are monitored through numerous programs including the Spring Phosphorus, Lake Assessment, and the Lay Monitoring Programs. While many lakes and ponds fully support the requirements of the VWQS, a number are impacted by acidification, and several exhibit high levels of mercury in fish. Both acid and mercury result from atmospheric deposition from sources outside of Vermont and are exacerbated by local geological conditions and water level manipulation.

Lake-specific information is compiled to create the Vermont Lake Score Card, which has been developed to convey a large amount of data gathered and analyzed through these monitoring efforts. The Score Card rates Vermont lakes in terms of water quality, aquatic invasive species, atmospheric deposition, and shoreland condition.

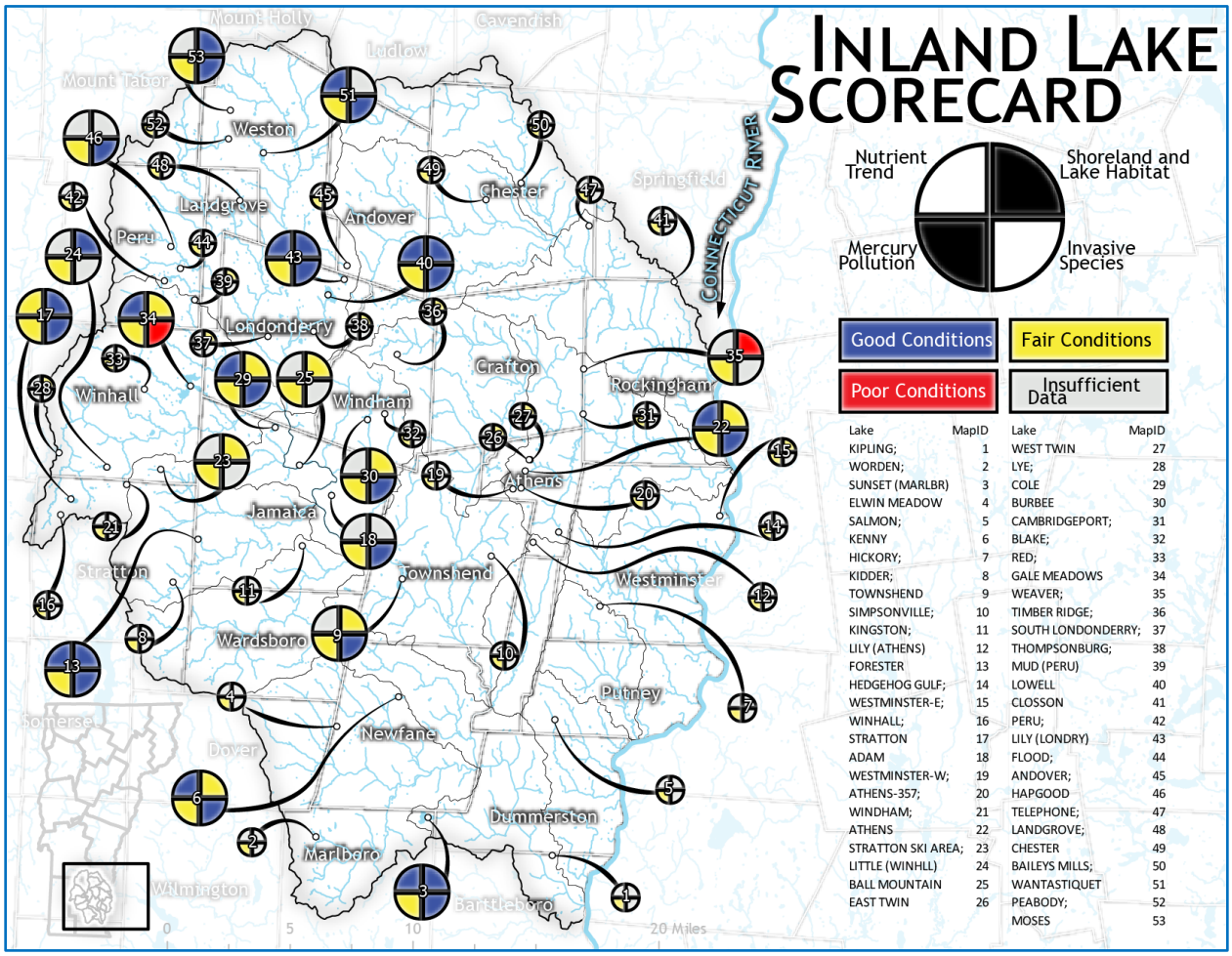


Figure 14. Lakes Scorecard

The greatest stressor to lakes in the Basin is atmospheric deposition resulting in elevated levels of mercury and low pH. Five lakes are impaired due to pH. Both these pollutants are attributable to the prevailing weather pattern that carries mid-west air pollution through the region, the proximity to those pollution sources and to the lack of buffering capacity of the bedrock geology. Three lakes are impaired for flow manipulation due to either flood control measures or recreational uses.

Table 3. Impaired Lakes

Impaired Lakes		
	pH	**Flow**
Ball Mountain Reservoir		X
Forester Pond	X	
Hapgood Pond		X
Lily Pond	X	
Little Pond	X	
Moses Pond	X	
Stratton Pond	X	
Sunset Lake	X	
Townshend Reservoir		X

Stratton Pond has been monitored since the 1980s as part of the Acid Lake and Spring Phosphorus Monitoring Programs. These data indicate increasing phosphorus concentrations over time. EPA researchers documented increasing phosphorus levels across the United States in relatively undisturbed watershed like Stratton's.[14] The mechanism causing this increase is not settled, but possible causes include increased runoff during extreme events due to climate change and increased atmospheric deposition of total phosphorus.

Gale Meadows Pond is the only lake with a known population of the aquatic invasive species Eurasian watermilfoil. It is recommended that a boat access Greeter Program be started to help prevent further spread and an invasive control treatment plan be developed.

Cole Pond (41 acres) in Jamaica and Stratton Pond (48 acres) in Stratton are currently monitored through the Lay Monitoring Program Cole Pond has mean spring and summer total phosphorus concentrations of 8.9 ug/L and 9.4 ug/L respectively, denoting that is an oligotrophic or low-nutrient lake and eligible for reclassification to A(1) or excellent status under Vermont's Water Quality Standards.

[14] John L. Stoddard, et al, 2016, Continental-Scale Increase in Lake and Stream Phosphorus: Are Oligotrophic Systems Disappearing in the United States?

Condition of Wetlands

The Vermont State Wetlands Inventory includes around 12,250 acres of wetland within Basin 11. This is out of 445,482 acres, thus comprising around 2.7% of the total area within this basin. Many, but not all, wetlands are identified on the Vermont Wetlands Inventory Map however, one study estimated that National Wetland Inventory maps, upon which Vermont Wetlands Inventory Maps are based, miss 82% of wetlands less than 3 acres in size and 68% of wetlands 3-20 acres in size. Hence many wetlands in the Basin may not be mapped.

Protecting, monitoring, and restoring wetlands is more effective when wetlands are publicly mapped. Improving wetland mapping coverage and accuracy in the Basin is a priority in order to properly evaluate wetland contributions to stormwater and floodwater storage, erosion control, water quality, fish and wildlife habitat and more. Towns experiencing strong development pressure or with many high value wetlands are particularly in need of accurate mapping which can be done using tools such as modern LIDAR imaging and field verification. Winhall, Stratton and Jamaica are priority towns for wetland mapping.

More than 35% of the original wetlands in Vermont have already been lost, primarily due to historical agricultural conversion. Identifying wetland restoration opportunities in the Basin is needed.

A total of 20 wetlands in Basin 11 have been assessed using the Vermont Rapid Assessment Method (VRAM). Of these, 10 were assessed during the most recent rotational basin field season in this basin, which was 2017. Eighteen of these are Level 3 assessments, which are detailed in-field assessments. The number of wetlands assessed is a relatively good representation given that the basin has relatively low levels of wetland coverage.

The VRAM assigns each wetland a score ranging from 15 to 100 with higher numbers representing more intact ecological condition and higher levels of wetland functions and values. The highest scoring wetland – Forester Pond Wetland – scored a 94. Nine other wetlands scored above 80, indicating excellent condition and/or very high levels of function and value. Only two wetlands scored below 50 – a roadside wetland along Route 9 and a tiny pocket wetland in the Turner Hill area with recent logging road impacts. The average score was 73. The majority of the basin is steep and forested, and has small, relatively remote wetlands that tend to be in good or excellent conditions. Lower wetland condition and function occur locally in association with development or agriculture, especially along the road corridors and in the larger river valleys.

Note that the VRAM assessments in this watershed may not necessarily be representative of wetlands as a whole, as random sampling was not conducted and a full inventory of all the wetlands in the basin is not possible at this time.

A number of the Basin's wetlands are within the USFS Green Mountain National Forest or are within state protected areas such as Gale Meadows WMA and Lowell Lake State Park affording them a high level of protection against disturbance. The two largest wetlands, Herricks Cove in Rockingham and the Retreat Meadows in Brattleboro, are created by backwaters of the Bellows Falls and Vernon hydroelectric dams on the Connecticut River. Additionally, these dams create Roundys Cove (AKA Upper Meadows) and Allbees Cove, also in Rockingham.

Outside of these areas, important wetlands in the Basin include those along Eddy Brook, Winhall River and Sacketts Brook. These are recommended for study for either reclassification or restoration.

Condition of Fisheries

The Vermont Fish & Wildlife Department assesses fishery populations and important nursery areas to document biological and habitat conditions to manage for high-quality recreational fisheries. These are typically found in surface waters that exhibit clean and cool conditions with well-vegetated riparian zones. Restoration of degraded conditions and protection of water quality and habitat are primary goals of the fisheries management program and are supported by this Plan. The full DFW Fisheries Assessment can be found as Appendix D.[15]

The West, Williams, and Saxtons watersheds and southern tributaries to the Connecticut River provide habitat for a variety of warm and cold-water fish species. The waterbodies in the watershed include reservoirs serving for flood control and hydropower operation, lakes and ponds which provide warmwater fisheries, small headwater streams providing cold-water habitat for trout, and large mainstem rivers which provide spawning and rearing habitat for Connecticut River diadromous species. Native Sea Lamprey *Petromyzon marinus*, American Eel *Anguilla rostrata* and American Shad *Alosa sapidissima* utilize the West, Williams, and other Connecticut River tributaries to spawn and rear, and all are designated as Species of Greatest Conservation Need (SGCN).

West River Mainstem

Recent sampling demonstrated that Brook Trout occupy the very upper reaches of this watershed while Brook and Brown trout occur in the mainstem but at relatively low abundances.[16] Diadromous species such as Sea Lamprey and American Eel can ascend the river up to Townshend Dam.

[15] Will, Lael, 2020, West, Williams, Saxtons, Watersheds and lower Connecticut Tributaries (Basin 11) Fisheries Assessment

[16] Abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (brook, brown and/or rainbow trout) at levels generally equal to or greater than 1,000 fish (≥ 6 inches in length) per stream-mile and/or 20 pounds per acre in small upland streams and greater than 200 fish per mile in larger streams and rivers.

Juvenile lamprey and American Shad have been found rearing in Retreat Meadows, a backwater to the Connecticut River located at the mouth of the West River.

There are four mainstem dams which occur in the towns of Weston (Weston Mill dam), Londonderry (Williams Dam), Jamaica (Ball Mountain Dam) and Townshend (Townshend Dam). These dams block fish passage and alter natural riverine processes including sediment and nutrient transport. Impoundments such as these also elevate temperatures thus degrading cold water habitats required for riverine species such as trout. Consideration should be given to removing the two upstream dams (Weston Mill and Williams), which would provide habitat connectivity and access to the cooler headwaters.

Williams River Drainage –

Trout monitoring within the basin is limited but includes the mainstem, South Branch, Middle Branch, and Andover Branch. Andover Branch historically had robust trout populations, but recent sampling indicated a decline. The site, however, meets the B(1) Fishing Criteria.

The South Branch of the Williams is monitored annually for trout abundances and stream temperatures. Warm stream temperatures are characteristic of the watershed and trout abundances remain relatively low.

Brockways Mills is a hydroelectric dam located about five miles upstream from the confluence with the Connecticut River. The dam is eight feet in height and is situated on a natural 30-foot cascade. It is not likely that diadromous species such as Sea Lamprey, and American Eel are able to migrate past the falls and dam, and they have not been observed above the dam. Sedimentation upstream of the dam has degraded riverine habitats.

Herricks Cove at the mouth of the Williams River is a backwater of the Connecticut River and provides unique habitat conducive to spawning and rearing of fishes that occupy the mainstem. For example, Northern Pike *Esox Lucius* spawn in shallow, well vegetated waters that border rivers and ponds. Historic fish sampling indicates that smallmouth bass, lake chub, white sucker, and chain pickerel occupy the cove, and it is likely many other species utilize this habitat as well. Efforts to evaluate the current fish assemblage in this water body should be pursued.

Saxtons River Drainage –

Trout population monitoring has occurred in Bull Creek, Howe Brook, Leach Brook, the South Branch and the Mainstem. Bull Creek is the only site that could potentially meet the B(1) Fishing Criteria pending additional sampling. The mainstem and South Branch contain very low numbers of trout likely due to warm temperatures.

The upper mainstem is sampled annually concurrent with stream temperatures. Trout abundances in this reach increased after Tropical Storm Irene likely due to some downed trees that spanned the channel width. The benefits of instream wood has been well documented as providing valuable cover, increasing habitat complexity, and retaining sediment, thereby improving habitat suitability for trout.

The South Branch and Saxtons River mainstem lack adequate riparian corridors and were heavily impacted due to post-Irene construction. Much of the instream habitat such as wood and large boulders was removed, and berms were constructed. Consequently, warm water temperatures, and lack of instream habitat contributes to the low abundances of trout in these rivers.

Lower in the river, Twin Falls, located about one mile upstream from the mouth is a natural barrier. A partially breached dam (Blake-Higgins Dam) occurs just below the Rte 5 bridge and is considered a barrier for most species. Removal of the remainder of the dam would provide access to spawning habitat between Twin Falls and the mouth.

Connecticut River tributaries –

Connecticut River tributaries are ecologically important due to their direct connection to the mainstem. These streams provide important spawning and rearing habitat, as well as thermal refuge during the warm summer months. Several of these streams meet the B(1) Fishing Criteria. American Eel have historically been observed in Sacketts Brook, and Rainbow trout occupy East Putney Brook and Morse Brook. Considering their connection to the mainstem and habitat requirements for diadromous species such as Sea Lamprey, providing fish passage at man-made barriers should be a priority.

Lakes & Ponds -

Ball Mountain and Townshend reservoirs impound the West River for Army Corps of Engineers Flood Control operations. The river downstream of the Ball Mountain Dam, which runs through the Jamaica State Park is stocked with Rainbow trout.

Townshend Reservoir is also stocked with Rainbow trout. Tropical Storm Irene deposited a substantial amount of sediment behind the dam reducing the quality and quantity of aquatic habitat. In 2014, the dams were retrofitted to accommodate a hydroelectric facility which includes a surface bypass system to allow fish to navigate past the dam without going through the turbines, and thus reduce fish mortality and project impacts.

For their fisheries, Gale Meadows, Lowell Lake, Retreat Meadows, Sunset Lake, Hapgood Pond, and Wantastiquet Lake are some of the more notable lentic waterbodies in the watershed.

Gale Meadows is a 195-acrea pond located in Winhall. It is known for its largemouth bass fishery and has a VFWD access area. In 2018, a fish community assessment was conducted in response to a spring fish kill. Although the direct cause of the fish kill in Gale Meadows is unknown, no evidence of a virus or toxic discharge was found, indicating it is likely that water quality played a role. As water temperatures warm with climate change, shallow ponds can experience shifts in dissolved oxygen levels, potentially resulting in levels too low for fish survival. With continued climate change, these events are expected to become more frequent.

Retreat Meadows is an approximately 80-acre setback of the West River in Brattleboro located just upstream of the confluence with the Connecticut River. The waterbody provides important spawning and rearing habitat for a variety of species and is a popular year-round fishery. The Meadows provides habitat for over 20 species of fish including American Shad, American Eel, and Sea Lamprey. Impacts to this ecologically important waterbody include post-Irene sedimentation and unnatural water level fluctuations due to dams during the spawning period that can dewater incubating eggs. It is anticipated that magnitude and frequency of these water level fluctuations will be reduced under the new FERC license for the Vernon project.

Hapgood Pond is 12 acres in size and is located in Peru. The pond impounds Flood Brook, a tributary to the West River. It is managed by the US Forest Service and provides recreational opportunities including fishing, and the VFWD stocks yearling Brook trout. Each year the pond is drained, which negatively impacts the biota within the pond as well altering flow and sediment discharges to the receiving waters (Flood Brook). Efforts to improve the management of the pond should be discussed with the U.S. Forest Service.

Rare, Threatened and Endangered Species

Northeastern bulrush
Photo courtesy of Center for Plant Conservation

There are two federally endangered species residing in the Basin. The Dwarf wedgemussel *Alasmidonta heterodon* is known to be in the Connecticut River in Rockingham and Springfield and in the lower reaches of some of the tributaries. Northeastern or Barbed-bristle Bulrush *Scirpus ancistrochaetus*, has been identified in the southeastern portion of the Basin in association with beaver wetlands.

Brook floater mussel
Photo courtesy of VDFW

Of great concern is the continued decline of the Brook Floater mussel, *Alasmidonta varicosa*. The lower West River below Ball Mountain dam is home to the only known population of Brook Floater in Vermont. Freshwater mussels are one of the most endangered group of organisms in North America, and the Brook Floater is among the most endangered in the Northeast. Brook Floater

populations in the West River below the Ball Mountain dam have declined over the last 20 years.[17] Another rare mussel species in the Basin is the Eastern pearlshell *Margaritifera margaritifera,* which is listed in Vermont as threatened.

The State threatened Cobblestone tiger beetle *Cicindela marginipennis* is known along the West and Connecticut Rivers and the Connecticut River was home to the likely extirpated Puritan tiger beetle *Cicindela puritana.*

Cobblestone tiger beetle
Photo courtesy of D. Sagan, USFWS

Two areas in the Basin host heavy concentrations of Rare, Threatened and Endangered Species (RTE) both due to the unique habitat conditions created by built infrastructure. These are Herricks Cove and the Retreat Meadows, both created by backwater from the large hydroelectric dams on the Connecticut River at Bellows Falls and Vernon respectively. The southern Connecticut River valley

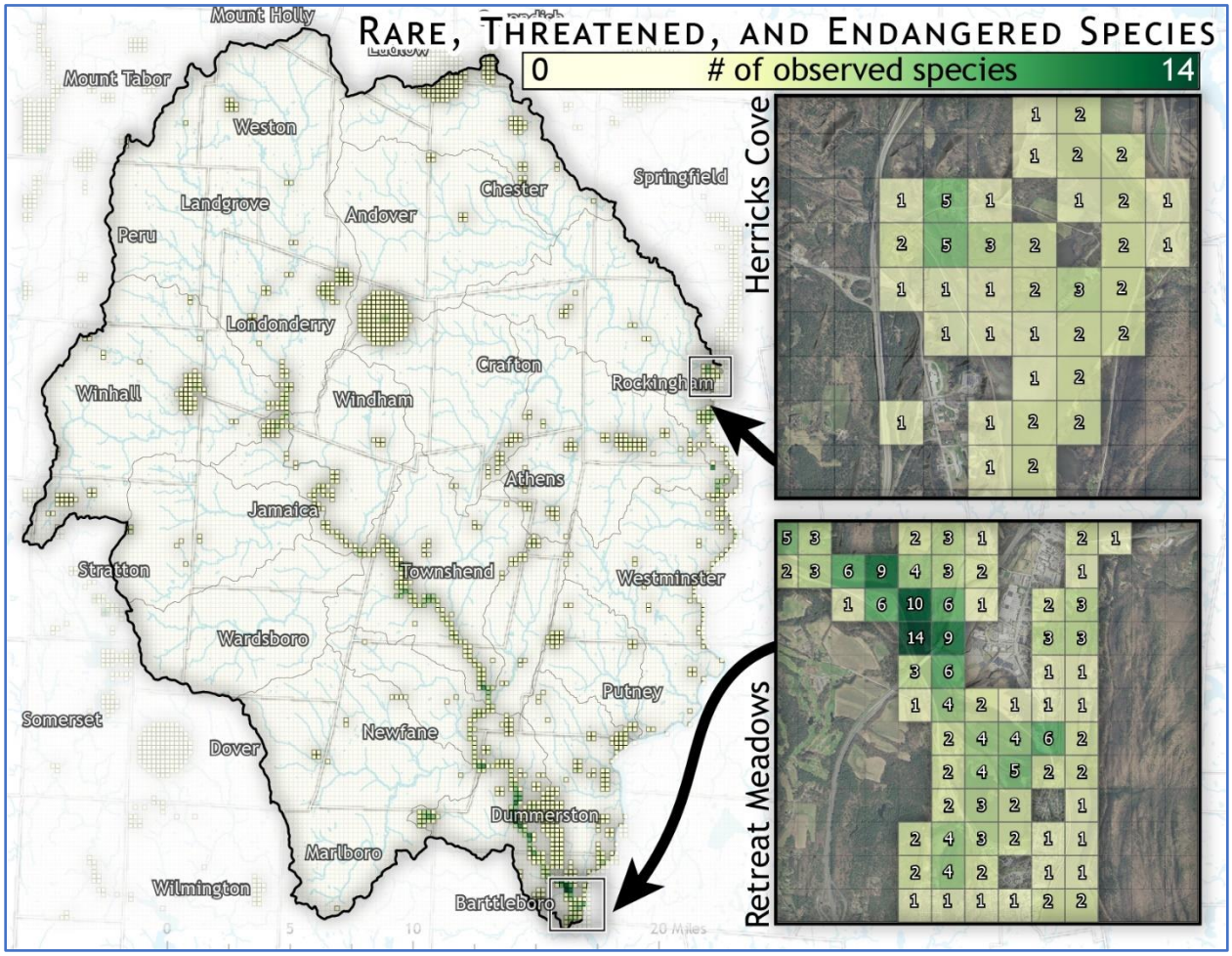


Figure 15. Rare, Threatened and Endangered Species Concentrations

[17] Biodrawversity, 2014, Brook Floater (Alasmidonta varicosa) in the West River in Vermont

in Vermont and New Hampshire, especially between Rockingham and Brattleboro, hosts a high concentration of rare, threatened and endangered (RTE) species, due in part to being at the northern edge of the range on numerous southern species. Figure 15. The river valley itself makes up the Middle Connecticut River Important Bird Area (IBA) for its recognition as an important flyway for migrating birds. Herricks Cove is also an IBA. This region is identified as a critical travel corridor for the wildlife movement due to the impacts of climate change. Protection of the travel corridor is a priority.

Water-based Recreation

Swimming, boating and fishing are all important recreational uses in the Basin and take place throughout its lakes, ponds, reservoirs, rivers and streams. These activities are both Designated Uses[18] and Existing Uses[19] and as such are protected through the VWQS. Documenting Existing Uses (EU) is required in all Tactical Basin Plans. The accumulated list of EUs is available in Appendix B. All Vermont lakes and ponds are assumed to be used for swimming so are not listed individually while river and stream sites are documented. Well-used swimming holes along rivers and streams are listed in the Appendix.

As part of the tactical basin planning process, public participation is sought to identify and inventory existing uses and the quality of these uses for protection.

Rainbow Rocks Photo Courtesy of Vermont River Conservancy

Newly protected for public access is Rainbow Rock Swimming Hole in Chester on the Williams River.

Public access to swimming and boating areas can put pressure on popular sites causing trail erosion, water quality issues, safety and private property trespass concerns. These areas require management that addresses both the environmental degradation and access availability. Use of recreational water resources is increasing, sometimes leading to increasing conflict between use groups. Vermont rivers and lakes are public resources for use and enjoyment by all. Ensuring equity of access to state waters is a Tactical Basin Plan priority and a State and ANR priority.

[18] - any value or use, whether presently occurring or not, that is specified in the management objectives for each class of water as set forth in §§ 3-02 (A), 3-03(A), and 3-04(A) of the Vermont Water Quality Standards.
[19] - a use that has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring.

Invasive Plants and Animals

Invasive species such as Japanese Knotweed *Reynoutria japonica* are widespread throughout these watersheds, particularly in the Williams and Saxtons Rivers. Preventative strategies are the most effective way in controlling the species. Inspecting and removing plants, fragments and seeds from gear, clothing, vehicles and equipment and ensuring soil, gravel and other fill materials are not contaminated and subsequently moved are some ways to help stop the spread (Invasive Species Council of British Columbia, 2019). In these watersheds, Knotweed tends to occupy habitats that have recently been disturbed or cleared (e.g., bank stabilization projects). Planting native vegetation shortly after riparian disturbance can help suppress colonization. [20]

A new introduction of an aquatic invasive species, Hydrilla *Hydrilla verticillata,* was found in the Connecticut River in 2017. Lakes and Ponds staff implemented early detection efforts, placed signage at VT river access areas, and conduct annual surveys in the Vernon/Hinsdale location to implement a rapid response if introduced. Local citizens and boaters should now be aware of the risk and how to initiate Clean, Drain, and Dry practices and spread prevention programs to boating recreationists.

Another problem species throughout the southern Connecticut River is Water chestnut *Trapa natans*. Initially documented in the Vernon/Hinsdale area in 2012, hand- harvesting continues each summer with noticeable reduction in the population. Other species of concern include Curly-leaf pondweed *Potamogeton crispus*, European Naiad *Najas minor*, Phragmites or Common Reed *Phragmites australis*, and Yellow flag iris *Iris pseudacorus*.

The Retreat Meadows is listed as Altered due to Eurasian watermilfoil and Herricks Cove is impacted as well. Both areas provide important habitat for RTE species and control measures should be undertaken. Establishing Greeter programs on the larger Basin lakes is recommended.

Additionally, more invasives are occupying riparian areas. Beyond the ubiquitous knotweed are Japanese bittersweet, Black Swallowwort, Buckthorn, Euanomous/Burning Bush and Japanese stilt grass. Potential control methods include manual removal with weed wrenches (shrubs), stem injection and hardware cloth applications (knotweed) and hand pulling for most. Spread prevention of all these species is a Basin priority. Experimenting with emerging technologies such as super-heated water treatment is encouraged.

Rusty crayfish *Faxonius rusticus* are fond in several Basin rivers and streams and their presence and spread should be tracked.

[20] VT DFW, West, Williams, Saxtons, Watersheds and lower Connecticut Tributaries (Basin 11) Fisheries Assessment

Chapter 2 – Priority Areas for Surface Water Protection

The Agency of Natural Resources is responsible for determining the presence of existing uses on a case-by-case basis or through basin planning and is also responsible for classification or other designations. Once the Agency establishes a management goal, the Agency manages state lands and issues permits to achieve all management objectives established for the associated surface water.

Before the Agency recommends management objectives through a classification or designation action, input from the public on any proposal is required and considered. The public may present a proposal for establishing management objectives for Agency consideration at any time, while the Agency typically relies on the publication of basin plans to identify candidates for reclassification (10 V.S.A. § 1424a). The Department of Environmental Conservation is developing and updating relevant procedures, forms, and guidance documents, as necessary, to enable submission, evaluation, and implementation of petitions to reclassify streams and lakes, and to designate Outstanding Resource Waters. The Department has developed these procedures and documents for Class I wetland designations. When the public develops proposals regarding management objectives, the increased community awareness can lead to protection of uses and values by the community and individuals.

As specified in the VWQS, all surface waters are managed to support designated uses valued by the public at a level of Class B(2) (i.e., good condition) or better. Designated uses include: swimming, boating, fishing, aquatic biota, aquatic habitat, aesthetics, drinking water source, and irrigation. This section of the plan identifies surface waters where monitoring data indicate conditions may meet or exceed the VWQS criteria for A(1) and B(1) designated uses. These high-quality waters may be protected by the anti-degradation policy of the VWQS or by upward reclassification or designation through one of the following pathways:

- Reclassification of surface waters
- Outstanding Resource Waters
- Class I Wetland
- Cold-water fisheries
- Identification of existing uses

In addition to the pathways provided by the VWQS, tactical basin plans identify opportunities to increase protection of high-quality waters through land stewardship programs, local protection efforts, conservation easements, and land acquisition.

VDEC has established narrative criteria for six of these classes and numeric criteria for aquatic biota, temperature, and aesthetics uses in Lakes and Ponds. VFWD has established narrative criteria for the fishing designated use. Monitoring data collected by both Departments provides the basis for evaluating the surface water classification for a given waterbody for a specific designated use.

Surface Water Classification

In order to protect Vermont surface waters and their designated uses, the VWQS establish water quality classes and associated management objectives for each class. The protection of water quality and water-related uses can be promoted by reclassification of waters into these classes. The management objectives describe the values and uses of the surface water that are to be protected or achieved. These are described in Table 4 and below.

Table 4. Vermont Water Classes

Protected Uses by Class (One or more may be included)	
A(1)	Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, swimming
A(2)	Public water source
B(1)	Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating
B(2)	Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, swimming, public water source, irrigation

Class A(1) waters are waters in a natural condition that have significant ecological value. By Vermont statute all surface waters above 2,500 feet of elevation are Class A(1). Below the 2,500-ft. elevation threshold, there are numerous surface waters which meet the biological criteria established for Class A(1), or exhibit characteristics consistent with Class A(1). These waters are or can be designated as Class A(1).

Class A(2) waters are waters of uniformly excellent character that, with filtration and disinfection, are suitable for use as a public water source.

Class B(1) waters are waters with minor changes from natural conditions of which one or more uses are documented to be higher quality than Class B(2) criteria for waters.

Class B(2) waters are waters that are suitable for: swimming and other primary contact recreation; irrigation and agricultural uses; aquatic biota and habitat; good aesthetic value; boating, fishing, and other recreational uses; and, with filtration and disinfection, as a public water source. Class B(2) is the base (or default) classification to which all surface water uses, excepting those already designated as Class A(1), A(2), and/or B(1) are managed.

A(2) Drinking Water Supply

The waters in Table 5 are currently identified as drinking water supply waters. However, several of these are no longer used as water supply. These waters may be reclassified through a petition process submitted to the Secretary of the Agency. Details of this process are currently under development.

Table 5. Current Drinking Water Supply Waters

Water Body
Chester Reservoir and the outlet stream above the water intake. **Abandoned** - Emergency - Village of Chester (WSID 5318) water source. Chester Reservoir, the outlet stream above the water intake, and all waters within their watersheds in the Town of Chester. The water intake is approximately 0.3 mile below the reservoir. Locally known as Pierce Brook Reservoir.
Bolles Brook (renamed Signal Hill Brook in 2016 by the Vermont Department of Libraries). Emergency - Vermont Academy (WSID 5303) water source. **Abandoned** – Village of Saxtons River. Bolles/Bowles Pond Brook (now Signal Hill Brook) and all waters in its watershed above the water intake in the Town of Rockingham.
Styles Brook. **Abandoned** - Stratton Corp. water source. Styles Brook and all waters in its watershed above the diversion to Styles Reservoir.
Mill Brook. **Abandoned** - Emergency - Kurn Hattin School (WSID 5452) water source. Mill Brook and all water within its watershed above the water intake in the Town of Westminster. The intake is located approximately 1.0 miles upstream of its confluence with the Connecticut River.
Sunset Lake and Stickney Brook. Sunset Lake – Permanent; Stickney Brook – Permanent - Town of Brattleboro (WSID 5290) water source. Sunset Lake, Langlie Brook, Kelly Brook, and Stickney Brook and all waters in their watersheds above the water diversions in the Towns of Dummerston, Marlboro, Newfane, and Brattleboro. (Also refer to the classification of Pleasant Valley Reservoir - Basin 13).
Back Pond/Minards Pond. Permanent - Village of Bellows Falls (WSID 5298) water source. Back Pond and all water within its watershed, which is diverted to Minards Pond. Back Pond is located 0.1 mile northwest of Minards Pond in the Town of Rockingham
Ellis Brook. Permanent - Village of Bellows Falls (WSID 5298) water source. Ellis Brook and all waters in its watershed above the water intake, which is situated at elev. 715' MSL in the Town of Rockingham.
Farr Brook. Permanent - Village of Bellows Falls (WSID 5298) water source. Farr Brook and all waters in its watershed above the water intake, which is located at elev. 710' MSL in the Town of Rockingham.

Minards Pond, Rockingham

A(1) Ecological Waters

Following recommendations in the 2015 Tactical Basin Plan, and working closely with the US Forest Service, five water were reclassified as A(1) waters in 2017. All Class A(1) are listed in Table 6.

All waters not designated as A(1) or A(2) are currently Class B(2). Many of these waters meet or exceed Class B(2) criteria or are being monitored to confirm their high quality conditions. Figure 16 and Table 6 present the protection priorities for reclassification and ORW designation for lakes, rivers and wetlands.

Figure 16. Protection Priorities

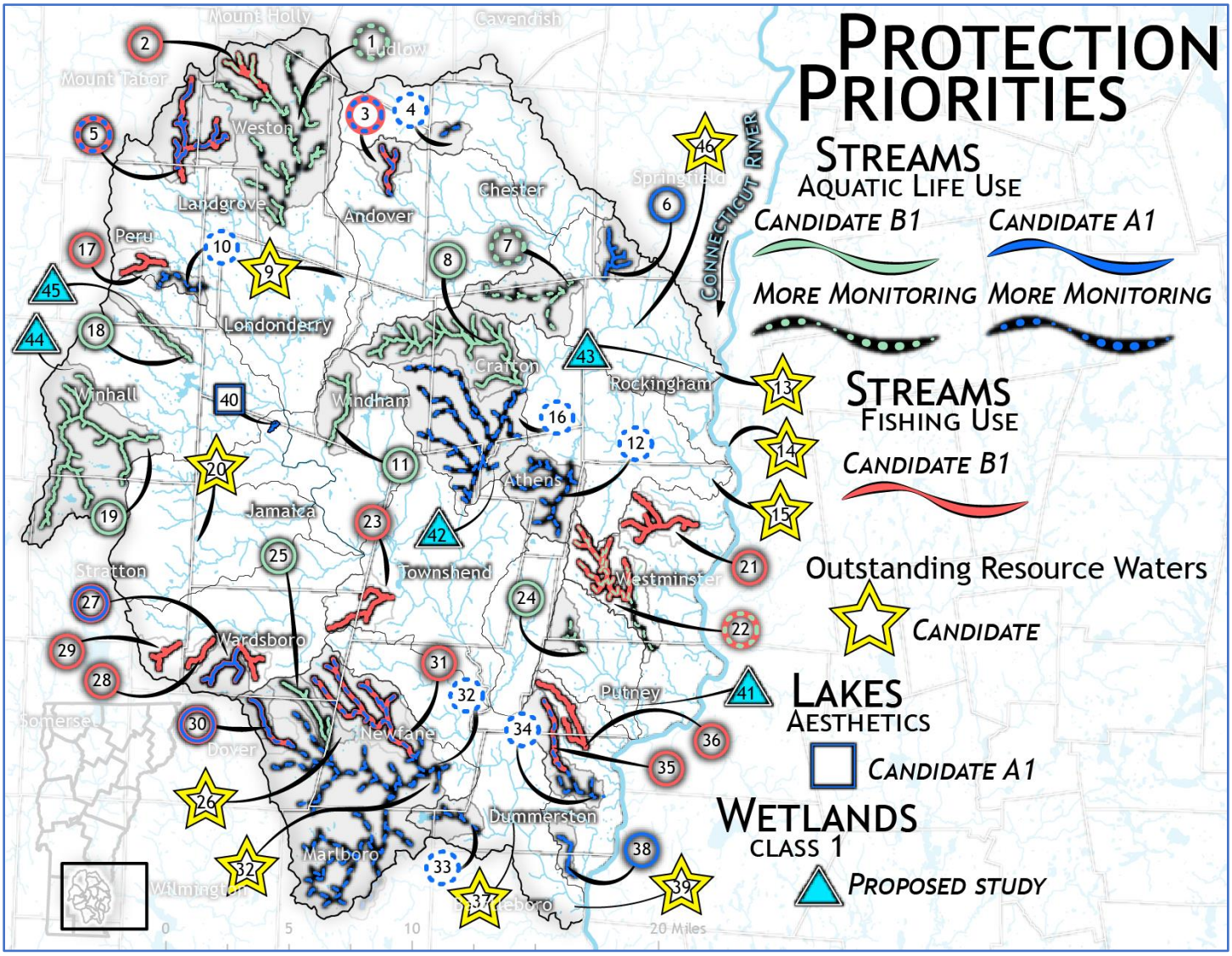


Table 6. Protection Priorities

Map ID	Stream Name	Reclass	Status	Use
1	Upper West River	B1	More Monitoring	Aquatic Biota
2	Greendale Brook	B1	Candidate	Fishing
3	Andover Branch	A1	More Monitoring	Aquatic Biota
3	Andover Branch	B1	Candidate	Fishing
4	Chase Brook	A1	More Monitoring	Aquatic Biota
5	Mount Tabor Brook	A1	More Monitoring	Aquatic Biota
5	Mount Tabor Brook	B1	Candidate	Fishing
6	Williams River Trib 11	A1	Candidate	Aquatic Biota
7	Hall Brook	B1	More Monitoring	Aquatic Biota
8	Upper Saxtons River	B1	Candidate	Aquatic Biota
9	Lily Pond	ORW	Candidate	Aquatic Biota
10	Burnt Meadow Brook	A1	More Monitoring	Aquatic Biota
11	Farnum Brook	B1	Candidate	Fishing
12	Eddy Brook	B1	Candidate	Aquatic Biota
13	Herricks Cove	ORW	Candidate	Aquatic Biota
14	Great Falls	ORW	Candidate	Aquatic Biota
15	Twin Falls	ORW	Candidate	Aquatic Biota
16	South Branch Saxtons	A1	More Monitoring	Aquatic Biota
17	Cobb Brook	B1	Candidate	Aquatic Biota
18	Bull Creek	B1	Candidate	Aquatic Biota
19	Winhall River	B1	Candidate	Aquatic Biota
20	Forester Pond	ORW	Candidate	Aquatic Biota
21	Morse Brook	B1	Candidate	Fishing
22	East Putney Brook	B1	Candidate	Fishing
22	East Putney Brook	B1	More Monitoring	Aquatic Biota
23	Fair Brook	B1	Candidate	Fishing

Map ID	Stream Name	Reclass	Status	Use
24	Upper Sacketts Brook	B1	More Monitoring	Aquatic Biota
25	Adams Brook	B1	Candidate	Aquatic Biota
26	Adams Brook & Bemis Brook	ORW	Candidate	Aquatic Biota
27	Waite Brook	A1	Candidate	Aquatic Biota
27	Waite Brook	B1	Candidate	Fishing
28	Dover Brook	B1	Candidate	Fishing
29	Pike Hollow Brook	B1	Candidate	Fishing
30	Head-waters Rock River	A1	Candidate	Aquatic Biota
30	Head-waters Rock River	B1	Candidate	Fishing
31	Baker Brook	B1	Candidate	Fishing
32	Rock River	A1	More Monitoring	Aquatic Biota
32	Rock River	ORW	Candidate	Aquatic Biota
33	Stickney Brook	A1	More Monitoring	Aquatic Biota
34	Salmon Brook	A1	More Monitoring	Aquatic Biota
35	Salmon Brook	B1	Candidate	Fishing
36	Canoe Brook	B1	Candidate	Fishing
37	Jelly Mills Falls	ORW	Candidate	Aquatic Biota
38	Crosby Brook South Branch	A1	Candidate	Aquatic Biota
39	Retreat Meadows	ORW	Candidate	Aquatic Biota
40	Cole Pond	A1	Candidate	Aesthetics
41	Sand Hill Road Complex	I	Proposed study	
42	Athens Dome Wetland Complex	I	Proposed study	
43	Herrick Cove	I	Proposed Study	
44	Winhall River Head-waters	I	Proposed study	
45	Eddy Brook Wetlands	I	Proposed Study	
46	Brockways Mills Gorge	ORW	Candidate	

Outstanding Resource Waters Designation

In 1987, the Vermont Legislature passed Act 67, "An Act Relating to Establishing a Comprehensive State Rivers Policy." A part of Act 67 provides protection to rivers and streams that have "exceptional natural, cultural, recreational or scenic values" through the designation of Outstanding Resource Waters (ORW). Depending on the values for which designation is sought, ORW designation may protect exceptional waters through the permits for stream alteration, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects and other activities. ORWs are waters which can be designated by the Agency of Natural Resources through a petition process. ORWs display outstanding qualities that are determined to deserve a higher level of protection. ORW designation may be based on any one or more of the following features:

1. existing water quality and current water quality classification;
2. the presence of aquifer protection areas;
3. the waters' value in providing temporary water storage for flood water and storm runoff;
4. the waters' value as fish habitat;
5. the waters' value in providing or maintaining habitat for threatened or endangered plants or animals;
6. the waters' value in providing habitat for wildlife, including stopover habitat for migratory birds;
7. the presence of gorges, rapids, waterfalls, or other significant geologic features;
8. the presence of scenic areas and sites;
9. the presence of rare and irreplaceable natural areas;
10. the presence of known archeological sites;
11. the presence of historic resources, including those designated as historic districts or structures;
12. existing usage and accessibility of the waters for recreational, educational, and research purposes and for other public uses;
13. studies, inventories and plans prepared by local, regional, statewide, national, or international groups or agencies, that indicate the waters in question merit protection as outstanding resource waters; and
14. existing alterations, diversions or impoundments by permit holders under state or federal law.

There is one ORW in the Basin. The North Branch Ball Mountain Brook is designated ORW from the mouth of Kidder Brook downstream for 4000 feet through the Pikes Falls recreation area.

The waters presented in Table 7 have been identified as prospective candidates for ORW based of the features listed above. As part of the implementation of this tactical basin plan, the Agency will support collaborative efforts to develop the materials, and to conduct outreach necessary to support rulemaking for ORW designation of these waters, should there be public interest. On receipt of a signed written request, the Secretary shall consider the adoption, amendment, or repeal of rules

regarding outstanding resource water designation and shall take appropriate action as required under 3 V.S.A. § 806. After consideration of all relevant information, the Secretary shall adopt rules designating the waters as outstanding resource waters if it finds that they have exceptional natural, recreational, cultural, or scenic values. (10 V.S.A. § 1424a).

Table 7. Outstanding Resource Water Candidates

Water	Location	Supporting Data	ORW Feature
Jelly Mill Falls, Stickney Brook	Dummerston	Unique geological feature, recreation	7, 8, 11, 12
Rock River	Dummerston, Newfane	Unique geological feature, recreation	7, 8, 11, 12
Adams Brook, Bemis Brook	Newfane	Unique geological feature	7
West River mainstem	Ball Mountain Dam to Connecticut River	High concentration of RTE, recreation, fish spawning	1, 4, 5, 6, 12
Twin Falls, Saxtons River	Westminster	Unique geological feature, scenic	7, 8
Lily Pond	Londonderry	Scenic & natural conditions, RTE, recreation	1, 5, 6, 8, 12
Forester Pond	Jamaica	Scenic & natural conditions, RTE, recreation	1, 5, 6, 8,12
Brockways Mills Gorge, Williams River	Rockingham	Unique geological feature, recreation	7, 8, 12
Connecticut River & Herricks Cove	Rockingham	High concentration of RTE	5, 6
Connecticut River & Retreat Meadows	Brattleboro	High concentration of RTE	5, 6
Connecticut River, Great Falls	Rockingham	1st canal in USA, 1st CT River bridge, petroglyphs, Great Falls, high concentration of RTE	5, 6, 7, 8, 10, 11

Class I Wetland Designation

It is policy of the State of Vermont to identify and protect significant wetlands and the values and functions they serve in such a manner that the goal of no net loss of such wetlands and their functions is achieved. Based on an evaluation of the extent to which a wetland provides functions and values, it is classified at one of three levels:

- **Class I**: Exceptional or irreplaceable in its contribution to Vermont's natural heritage and therefore, merits the highest level of protection
- **Class II**: Merits protection, either taken alone or in conjunction with other wetlands
- **Class III**: Neither a Class II or Class I wetland

Impacts to Class I wetlands may only be permitted when the activity is necessary to meet a compelling public need for health or safety. The VT Wetlands Program has created a Class I website with an interactive map.

In the case of wetlands that provide exceptional function or value, the option exists for community or watershed groups to petition to have these wetlands re-classified as 'Class I wetlands' which offers a higher level of protection and visibility. A full inventory of wetlands does not exist for this watershed, and in fact many exceptional wetlands likely have not yet been documented. Further inventory including both mapping and field work as well as community and landowner outreach should occur to help determine which wetlands are the most important for each Vermont Wetland Rules values (Education and Research in Natural Sciences; Open Space and Aesthetics) and certain functions (erosion control, flood storage, water quality) are under-analyzed and are needed. Despite the lack of a formal inventory of wetland presence, some wetlands are known to be higher quality. Several wetlands in this watershed have already been discussed as potential candidates.

While there are currently no Class I wetlands in the Basin, as part of the development of this tactical basin plan, several surface waters have been identified as wetlands to study for Class I potential. These are listed in Table 8 below.

Table 8. Wetlands for Further Study for Class I Designation

Wetland	Status
Eddy Brook Wetlands	Proposed for Study
Winhall River Headwaters Wetlands	Proposed for Study
Putney's Sand Hill Road complex	Proposed for Study
Herrick's Cove Rockingham	Proposed for Study
Athens Dome Wetland Complex	Proposed for Study

Warm and Cold-Water Fish Habitat Designations

To provide for the protection and management of fisheries, waters are designated in the VWQS as being either a cold or a warm water fish habitat. Where appropriate, such designations may be seasonal. Generally, warm water fish habitat is held to a less stringent water quality standard than cold water fish habitat, allowing more fluctuation in water temperature and dissolved oxygen.

The following waters are designated as warm water fish habitat. All waters not designated as warm water fish habitat are designated as cold water fish habitat.

Table 9.

Warm Water Fish Habitat	
Burbee Pond	Windham
Cole Pond	Jamaica
Lily Pond	Londonderry
Lowell Lake	Londonderry
Mindards Pond	Rockingham

All wetlands are designated as warm water fish habitat, except those specifically designated as cold-water fish habitat which includes those wetlands adjacent to the headwaters of the Winhall River and its tributaries on the east and west side from the outlet of Stratton Pond to the Stratton-Winhall boundary, a distance of approximately 2.0 miles.

Identification of Existing Uses

The VANR may identify existing uses of waters during the tactical basin planning process or on a case-by-case basis during application reviews for state or federal permits. Consistent with the federal Clean Water Act, the VWQS stipulate that existing uses may be documented in any surface water location where that use has occurred since November 28, 1975. Pursuant to the definition of Class B(1) in Act 79[21], the VANR may identify an existing use as Class B(1) when that use is demonstrably and consistently attained.

The VANR stipulates that all lakes and ponds in the state have existing uses of swimming, boating, and fishing. The VANR recognizes that fishing activities in streams and rivers are widespread and too numerous to thoroughly document. In the case of streams too small to support significant fishing activity, the VANR recognizes these as potential spawning and nursery areas, which contribute to fish stocks downstream where fishing may occur. These small streams support the use of fishing and therefore, are protected at a level commensurate with downstream areas.

Listed existing uses in the Basin should be viewed as a partial accounting of known existing uses based upon limited information. The list does not change protection under the Clean Water Act or VWQS for unlisted waters. The existing uses of swimming, boating, fishing, and drinking water supply are found in Appendix B. The public is encouraged to recommend waters for existing uses of swimming, boating, fishing, drinking water, and ecological significance given that they provide evidence of such use and the level of water quality necessary to protect those uses.

[21] Sec. 1. 10 V.S.A. § 1252

Canoe and kayak paddling are important recreational uses in the Basin especially along the mainstem West River, the Rock and Winhall Rivers and Wardsboro Brook. The USACE flood control dams at Ball Mountain and Townshend have long conducted whitewater releases on West River for recreational boaters. These events are required to operate according to the Coordination Plan for Operating Federal Flood Control Dams in Vermont established in 2004 between USACE, USFWS and ANR (see Appendix E.a.). However, the flow alterations associated with these releases have been demonstrated to negatively impact aquatic biota.

The flow management during these events has caused fish stranding as evidenced by surveys conducted by VTFWD[22] (see Appendix E.c.). An ongoing area of concern expressed by stakeholders is that the USACE has not followed its flow agreement with ANR since 2014. ANR fully supports recreational and whitewater boating on the West River at natural flows and at release flows that comply with the minimum conservation flows, ramping rates and reservoir refill rates agreed upon. ANR also recognizes the challenges of managing flows for both recreation and aquatic ecology. ANR will continue to engage with USACE to address this issue as part of plan implementation.

[22] McHugh, P. and Will, L., 2019, Assessment of the 2019 USACE whitewater release effects on aquatic resources of the West River.

Chapter 3 – Priority Areas for Surface Water Restoration

A. Stressed or Impaired Waters

The VDEC monitors and assesses the chemical, physical, and biological status of individual surface waters to determine if they meet the VWQS per the 2019 Vermont Surface Water Assessment and Listing Methodology[23]. Surface waters are assessed as: full support, stressed, altered, or impaired. To address Section 303(d) of the Federal Clean Water Act, the VDEC develops the 303(d) List of Impaired Waters, which includes impaired lakes, ponds, rivers, and streams that do not meet VWQS.

The State also produces the Priority Waters List, which identifies other waters that do not meet water quality standards, but do not require a TMDL as other pollution control mechanisms are in place. Sections of that list include: Part B-impaired waters that have other required remediation measures in place; Part D-impaired waters with TMDLs in place; Part E-waters altered by Aquatic Invasive Species (AIS); and Part F-waters altered by flow modifications. These lists can be viewed on the DEC Assessment and Listing webpage. More detailed monitoring results are available through the Vermont Integrated Watershed Information System (IWIS) online data portal. Figure 17 and Table 10 show the known stressed, impaired, or altered waterbodies in Basin. The State of New Hampshire follows a similar process for identifying impaired waters and so Connecticut River segments to which this basin drains that are listed as impaired by the State of New Hampshire are also included the Table and Figure.

A primary goal of this plan is to identify and address stressors degrading the listed waters by implementing strategies listed in the Chapter 5 Implementation Table. The types of strategies

[23] Dec 2019, https://dec.vermont.gov/watershed/map/strategy

prescribed are based on the sector-specific practices outlined in the Vermont Surface Water Management Strategy.

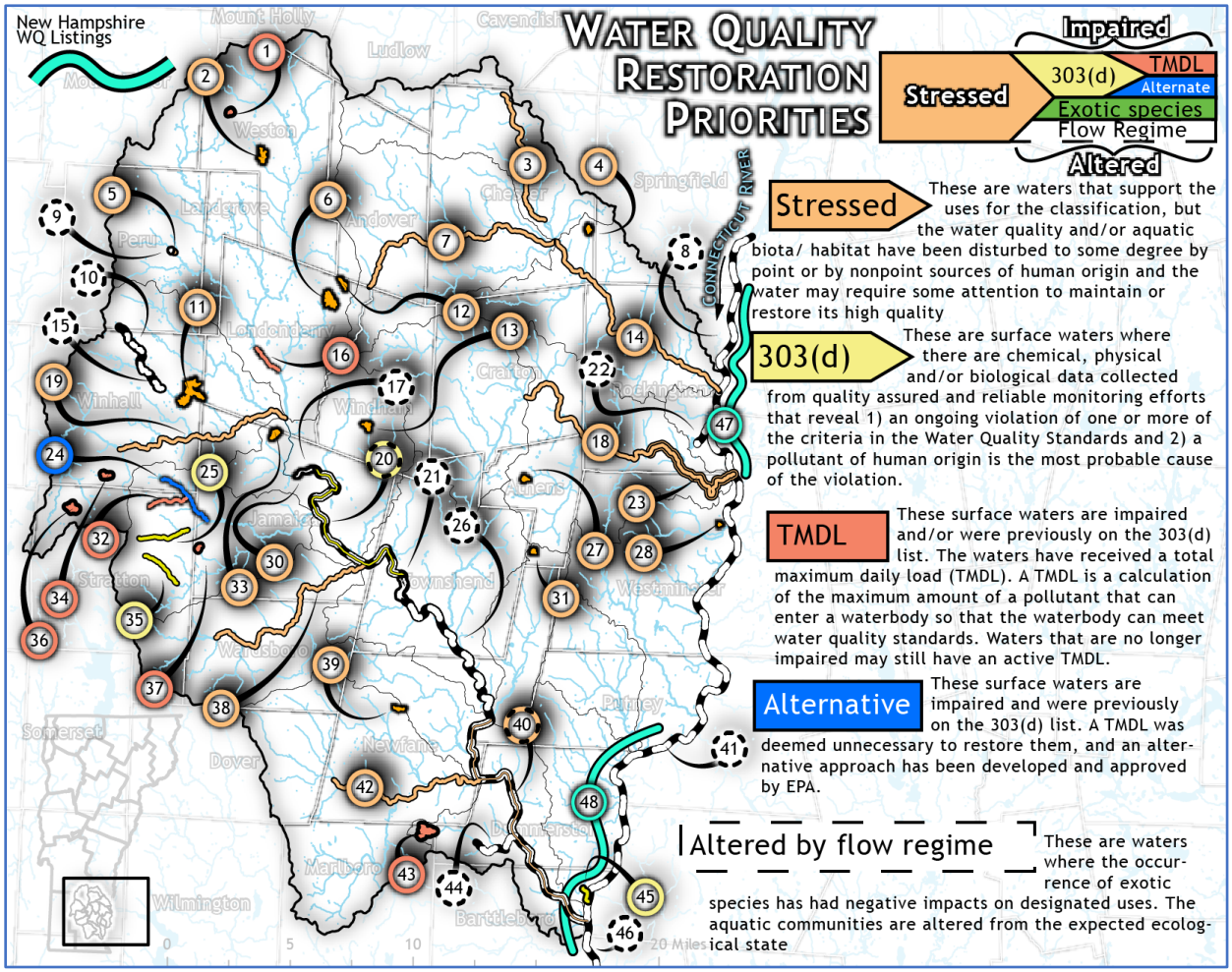


Figure 17. Priority Waters and Pollutants

Table 10. Priority Waters and Pollutants

Map ID	Waterbody	Listed as:	For the Pollutant:
20	West River, below Ball Mountain Dam	Impaired / Altered	Temperature / Flow regime modification
24	North Branch Ball Mountain Brook	Impaired	Manganese
25	Kidder Brook	Impaired	Acid
35	Bear Creek	Impaired	Acid
45	Crosby Brook	Impaired	Sedimentation/ Siltation
47	Connecticut River -Charlestown, NH to Bellows Falls, VT	Impaired	Flow regime modification, pH (NH)
48	Connecticut River - Poocham, NH to Brattleboro, VT	Impaired	Flow regime modification, pH (NH)

1	Moses Pond	TMDL	Acid
16	West River, South Londonderry	TMDL	*E. coli*
32	Styles Brook	TMDL	Sediment
34	Little Pond	TMDL	Acid
36	Stratton Pond	TMDL	Acid
36	Stratton Pond	TMDL	Acid
37	Forester Pond	TMDL	Acid
43	Sunset Lake	TMDL	Acid
8	CT River below Bellows Falls Dam	Altered	Flow regime modification
9	Hapgood Pond	Altered	Flow regime modification
10	Trib to Mill Brook	Altered	Flow regime modification
14	Farr Brook, below Minards Pond	Altered	Flow regime modification
15	Mill Brook	Altered	Flow regime modification
17	Ball Mountain Reservoir	Altered / Stressed	Flow regime modification / Acid
21	Townshend Reservoir	Altered	Flow regime modification
40	West River, mouth to Grassy Brook	Altered / Stressed	Flow regime modification / Temperature
44	Stickney Brook	Altered	Flow regime modification
2	Wantastiquet Lake	Stressed	Acid
3	Williams River, above Chester Village	Stressed	Temperature, Sediment
4	Telephone Pond	Stressed	Acid
5	Flood Brook, below Hapgood Pond	Stressed	Temperature, low oxygen
6	Lowell Lake	Stressed	Acid
7	Middle Branch Williams River	Stressed	Physical alterations
11	Gale Meadows	Stressed	Acid, Eurasian watermilfoil
12	Lily Pond (Londonderry)	Stressed	Acid
13	Burbee Pond	Stressed	Acid
14	Lower Williams River	Stressed	Sediment, Nutrients, Temperature
18	Lower Saxtons River	Stressed	Sediment, Temperature
19	Winhall River, IP CO Bridge to mouth	Stressed	Sediment, Temperature
23	Lower Saxtons River, below WWTF	Stressed	Phosphorus
27	Athens Pond	Stressed	Acid
28	Westminster Pond	Stressed	Phosphorus, Flow regime modification
31	Lily Pond (Athens)	Stressed	Acid
33	Cole Pond	Stressed	Acid
38	Wardsboro Brook	Stressed	Sediment, Temperature
39	Kenny Pond	Stressed	Acid

42	Rock River, mouth to Adams Brook	Stressed	Sediment, Temperature, Physical alterations

B. Basin Specific Total Maximum Daily Loads (TMDLs)

A Total Maximum Daily Load (TMDL) is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for reducing water pollution from specific point source discharges or for an entire watershed to determine the location and amount of needed pollution reductions. Tactical Basin Plans serve as implementation plans to guide the actions necessary to meet TMDL reduction targets specific to each planning basin.

TMDLs for Basin 11 include:

- 2003 TMDL for 30 Acid Impaired Lakes in Vermont (Forester, Moses, Stratton, Sunset - Marlboro)
- 2004 TMDL for 7 Acid Impaired Lakes (Little - Winhall)
- 2012 TMDL for 2 Acid Impaired Lakes (Lily -Londonderry)
- Vermont Statewide TMDL for Bacteria-Impaired Waters Final
    - Appendix 15 - West River
- Long Island Sound (LIS) Dissolved Oxygen TMDL

The TMDLs for Acid Impaired Lakes are primarily focused on regional efforts to reduce atmospheric deposition and so are not described in greater detail beyond the link provided above. However, the Long Island Sound Dissolved Oxygen TMDL and Bacteria TMDL are described in greater detail below.

Long Island Sound TMDL

The Long Island Sound Dissolved Oxygen TMDL released in 2000 is designed to address low dissolved oxygen or hypoxia in Long Island Sound bottom waters. It is often referred to as the Connecticut River Nitrogen TMDL because it is linked to an overabundance of nitrogen discharging into the Sound from the Connecticut River and other tributaries. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of algae. When the algae die, they sink to the bottom, where they are consumed by bacteria. The microbial decay of algae and the

respiration of these organisms uses up the available oxygen in the lower water column and in the bottom sediments, gradually reducing the dissolved oxygen concentration to unhealthy levels.[24]

Due to the Long Island Sound TMDL nitrogen is a key pollutant of concern in the Connecticut River watershed. Total Nitrogen (TN) levels, the apex indicator in the Connecticut River watershed, show correlation with development and impervious surface increases. Stormwater and agricultural runoff are common contributors of nitrogen.

Vermont's nitrogen export to LIS is estimated to be about 12% of the total load to the Sound based on the recently published SPARROW model.[25] Basin 11 is responsible for approximately 16% of Vermont's load. This delivered loading is 1% from municipal wastewater treatment, 12% from developed land runoff, 9% septic system effluent, and 7% from agriculture through nitrogen fixing crops, farm fertilizer and manure (Figure 18).[26] Approximately 71% of nitrogen from the Basin comes from atmospheric deposition.[27] Figure 19 shows the delivered loading in kilograms per square kilometer. Efforts to reduce atmospheric deposition have been occurring at the national level through the 1990 Clean Air Act and its amendments. Total nitrogen deposition has declined since 1985.

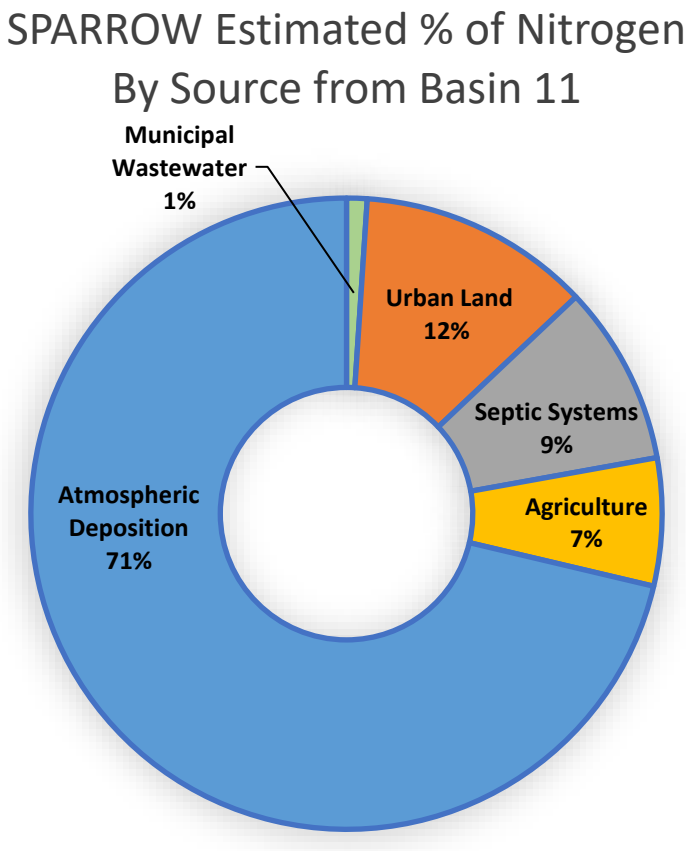


Figure 18.

[24] A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound

[25] Spatially Referenced Models of Streamflow and Nitrogen, Phosphorus, and Suspended-Sediment Loads in Streams of the Northeastern United States

[26] Ibid.

[27] Ibid.

In 2017, USEPA embarked on its Nitrogen Reduction Strategy to investigate and better define control strategies to reduce nitrogen in the Long Island Sound. Information on the most current developments and strategies can be found in USEPA's Long Island Sound Study.

The sources of nitrogen to be addressed in Vermont include wastewater and septic discharges, agricultural lands, developed lands, and forest practices. The adoption of Vermont's Act 64 , the Vermont Clean Water Act, helps implement overarching strategies and steps required to meet loading reductions for the Long Island Sound's TMDL.

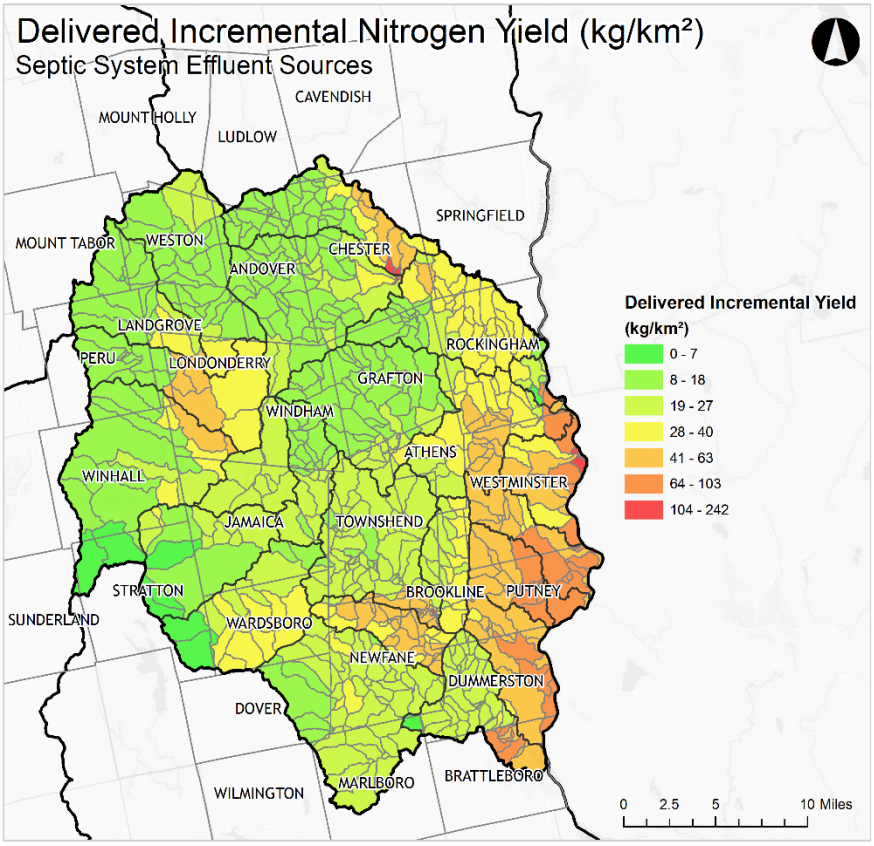


Figure 19. SPARROW model estimates of Nitrogen loading reaching Long Island Sound per square kilometer (Yield) from catchments in Basin 11 from: Septic systems (A), Urban sources (B) and agricultural (manure, fertilizer, nitrogen fixing crops) (C).

Figure 19. A

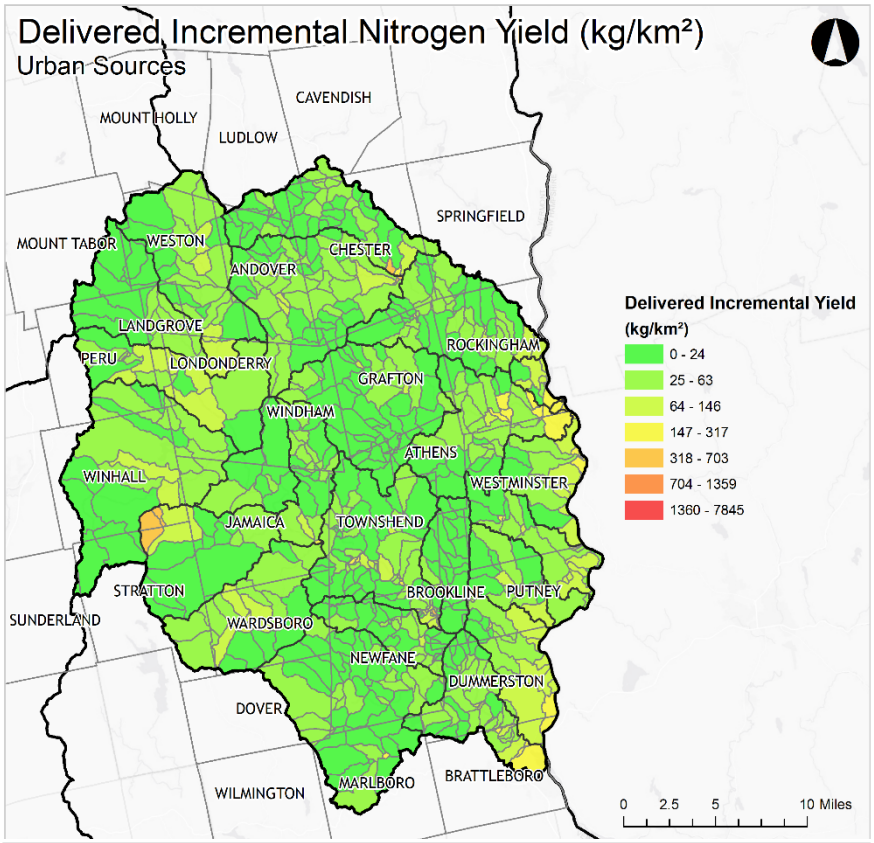


Figure 19. B

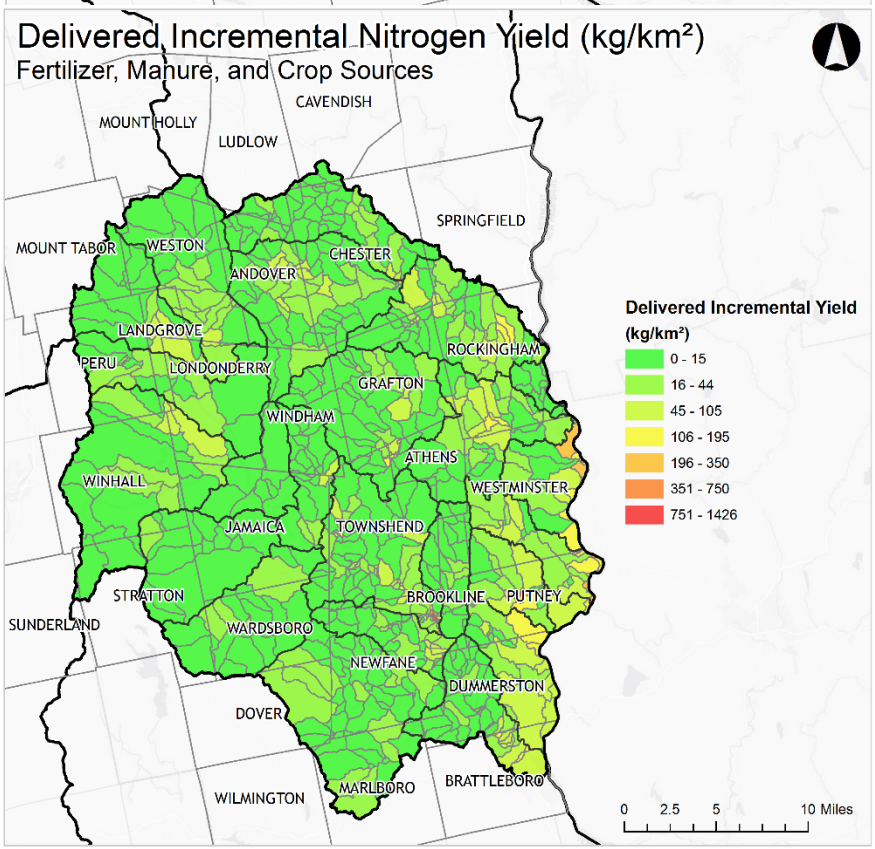


Figure 19. C

In 2013 a Vermont-specific section, the Vermont Enhanced Implementation Plan for the Long Island Sound TMDL was added to the LIS-TMDL to address four goals:

1. To identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested;
2. To identify the status and trends of important drivers of nitrogen export such as the intensity of agricultural and development activities and investigate how these might have changed since the TMDL baseline period of 1990;
3. To identify the management programs, operating at that time, that address these drivers of nitrogen loading that have a significant effect on reducing or preventing nitrogen export. A part of this is to identify a timeline as to when programs were initiated or enhanced; and
4. Using a weight-of-evidence approach, to assess the combined management programs/projects to develop a qualitative evaluation as to whether management efforts are sufficient to meet the original 2000 TMDL of a 10% non-point source nitrogen reduction and if these strategies are sufficient to maintain that control into the future.

In addition, the Long Island Sound Watershed Regional Conservation Partnership Program (LISW-RCPP) was created in 2015 across six states to coordinate the development and implementation of a comprehensive working lands program with foci on: 1) nutrient management and soil health, 2) protection of non-industrial forest habitat, biodiversity, and drinking water sources, and 3) stream erosion and flood resiliency improvements on working lands through riparian restoration. In partnership with the Vermont Association of Conservation Districts (VACD), UVM Extension, the Connecticut River Conservancy, The Nature Conservancy and federal, state and local organizations in VT, NH, MA, CT, NY and RI, ten million dollars is being invested in the adoption of best management practices on private working lands, providing both technical and financial assistance.[28]

[28] Connecticut Council on Soil and Water Conservation, 2015

Chapter 4 – Strategies to Address Pollution by Source Sector

Tactical Basin Plans address water quality by sector as summarized in the following sections which are consistent with the Clean Water Initiative Program's 2020 Performance Report. The following sections provide specifics about protection and restoration efforts underway or recommended for each source sector. A summary table of the strategies for each sector is found in the Executive Summary in Table 1. A more detailed list of priority strategies by source sector is included in Chapter 5 in the Implementation Table Summary.

A. Agriculture

Agricultural land use makes up approximately 5 percent of the land cover in the Basin, 4% of which is in hay or pasture leaving only 1 percent in cultivated crops (Figure 20). Corn, alfalfa and apples make up the majority of cultivated agricultural land use in the Basin.

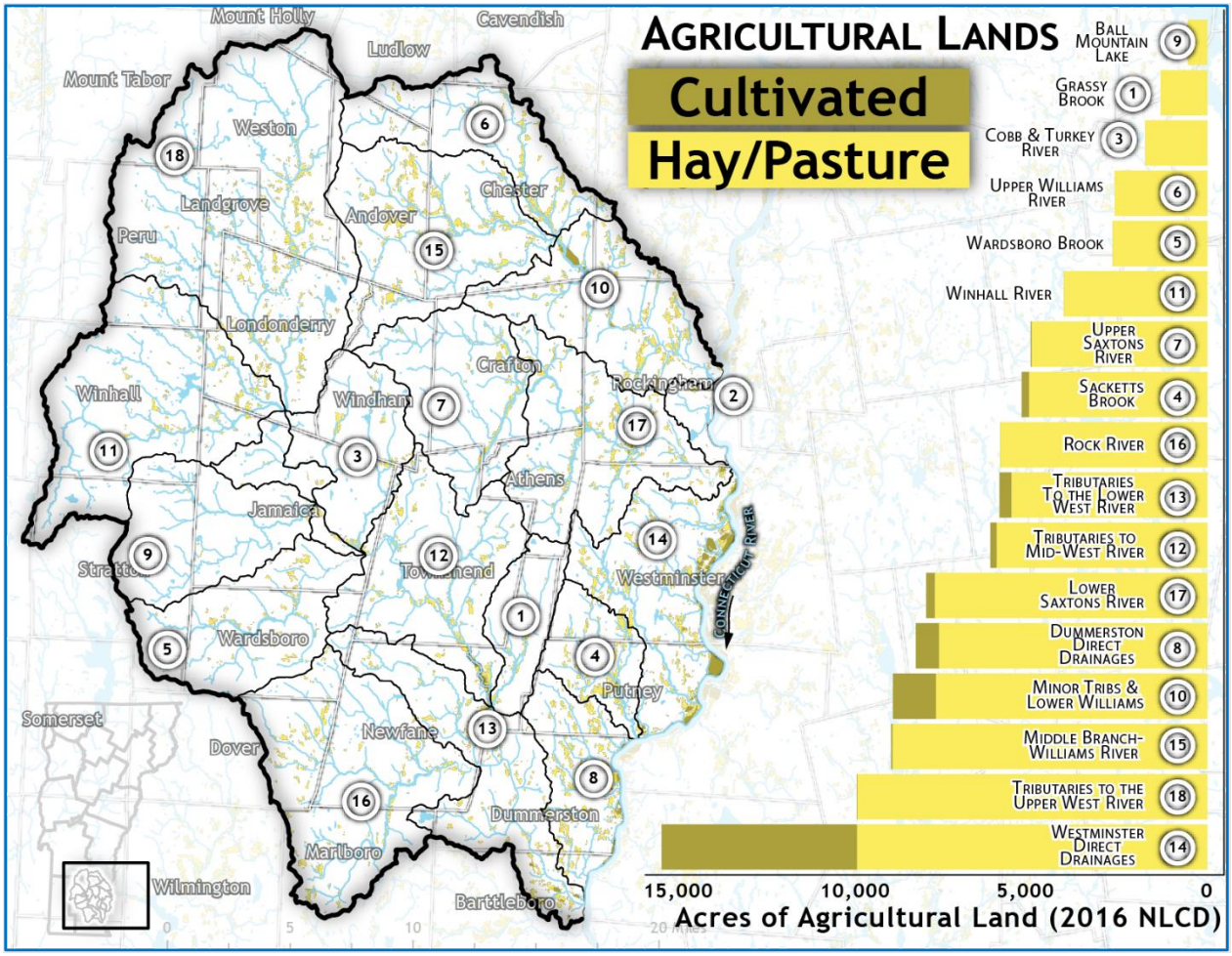


Figure 20. Agricultural Lands Use

Runoff from agricultural land is estimated to contribute 7% of the nitrogen from this basin to Long Island Sound from fertilizer, manure, and agricultural field runoff. Nitrogen is a driver of low dissolved oxygen levels addressed in the Long Island Sound Dissolved Oxygen Total Maximum Daily Load (TMDL). Over 32% of agricultural land use in the Basin is along the Connecticut River. As reflected in Figure 19.c., catchments in this area contribute higher levels of nitrogen to the Connecticut River then the remainder of the Basin. Runoff from agricultural lands may also contribute to elevated levels of *E. coli* along several reaches which are listed as impaired by New Hampshire Department of Environmental Services.

The lower Williams River is listed as Stressed for sediment, nutrients, and temperature due to agricultural runoff and the lack of riparian buffers, while the mainstem above Chester village is listed as Stressed for sediment and temperature due to similar riparian conditions. Other regions where the lack of riparian buffers on agricultural lands is of concern are the upper West River and the lower Saxtons River. Further data is being collected to identify sources of bacteria in Sacketts Brook below several streamside agricultural operations.

Vermont Agency of Agriculture, Food, and Markets (AAFM) regulatory programs work towards protecting surface waters by requiring baseline farm management practices to ensure environmental stewardship. The recent revisions of the Required Agricultural Practices (RAPs) in 2016 and 2018 aim to reduce nutrients such as phosphorus and nitrogen entering state waterways. The RAPs apply to different types of farms, farm sizes and farming activities. In addition to the RAPs, Vermont farms are regulated by additional sets of rules promulgated by the AAFM based on farm animal numbers into large, medium, certified small and small farms as shown in this graphic[29]. There is one permitted Large Farm Operation (LFO) and one permitted Medium Farm Operation (MFO) and five Certified Small Farm Operations (CSFOs) in the Basin. LFOs are inspected annually, MFOs are inspected at least once every three years and CSFOs are inspected at least once every seven years by the AAFM. AAFM estimates there are nineteen Small Farm Operations (SFOs) in the Basin that do not meet the thresholds of a CSFO and thus are not required to receive a routine inspection by AAFM, but do still need to comply with the RAPs.

AAFM regulatory programs support farmers to ensure their clear understanding of the RAPs and program rules, while helping assess, plan, and implement any conservation and management practices necessary to meet water quality goals. Inspections by AAFM include assessments of farm nutrient management plans (NMPs), production area assessments of all facilities associated with the permitted or certified operation, and cropland management assessments in accordance with RAPs and permit rules as applicable.

Availability of technical and financial assistance throughout the Basin is provided by the Windham County and Ottauquechee Natural Resources Conservation Districts, UVM Extension, AAFM, and the Natural Resources Conservation Service (NRCS), who help facilitate compliance with water quality regulations and the voluntary adoption of conservation practices. AAFM and NRCS funded programs provide the majority of financial support directly to farmers as well as to the agricultural partner organizations. Outreach, education, technical assistance, and financial assistance is available for farmers to implement field Best Management Practices (BMPs), such as cover cropping, crop rotation, and reduced tillage practices, and also available for farmers to implement farmstead BMPs, such as waste storage facilities or clean water diversion practices. These agricultural assistance and outreach programs are essential tools in promoting field and farmstead BMPs that protect water quality, improve soil health and. increase farm viability.

[29] http://agriculture.staging.vermont.gov/sites/agriculture/files/documents/Water_Quality/FarmSizeClass.pdf

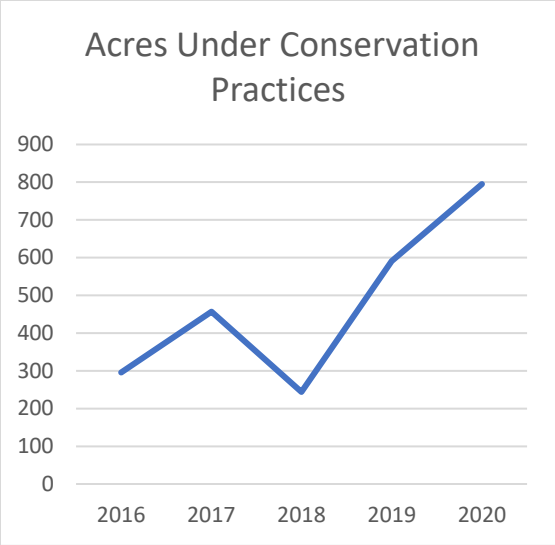


Figure 21. Agricultural Acres Under Conservation Practices

The VDEC analyzes and tracks agricultural conservation practices implemented between FY2016-2020 through federal NRCS and State funded programs. This data shows that adoption of conservation practice implementation is growing in the Basin. Figure 21 show the increased implementation of field BMPs in the Basin with approximately 800 acres of conservation practices such as cover cropping and crop rotation implemented with State and Federal funding in SFY 2020.

The majority of farms in the Basin are small operations that do not require inspections. This highlights the need for additional support for general technical assistance to provide these operations with information and resources to assist them in meeting water quality requirements of the RAPs. Without the more consistent contact with AAFM inspection and technical assistance staff these operations may have difficulty being aware of requirements and accessing assistance resources. NRCS recommends working with farmers to complete the Conservation Assessment Ranking Tool (CART) to assist in linking the farm to the most useful available tools. CART is used to assess clients' resource concerns, planned practices, and site vulnerability as part of the conservation planning process and helps rank client applications for NRCS program funding. This assessment will help Basin farms qualify for Federal assistance based on priority resource issues.

Additional assistance and support is offered by the Connecticut River Watershed Farmers Alliance, "a farmer-driven 501(c)3 non-profit organization dedicated to helping agricultural producers in the Connecticut River Watershed in VT and NH improve agricultural land stewardship practices for clean waterways, healthy soil, and productive landscapes through workshops, discussions, resource sharing, and education. CRWFA members serve as advocates for our community, ensuring voices of farmers are well represented in legislative and policy initiatives affecting the agriculture industry." CRWFA hosts events for farmer discussion, provides educational resources, and offers conservation tillage and cover cropping equipment for rent to improve and maintain water quality by supporting agricultural producers in their conservation efforts.

Since 2016 over $1.62 million dollars in state grants and loans have been invested in implementing or preparing to implement agricultural improvement projects in the Basin.

Table 11. State Investment and Outcomes of Agricultural Improvement Projects

Project Development & Output Measures	SFY 2018	SFY 2019	SFY 2020	Total
Acres of agricultural conservation practices implemented (excluding other practices)		40	163	**203**
Acres of water quality protections within newly conserved agricultural lands		34		**34**
Number of barnyard and production area practices installed	4		2	**6**

Clean Water Goals for Agriculture

- Focal areas for agricultural field and farmstead BMPs include the Williams River, the upper West River and the lower Saxtons River watersheds
- Riparian buffers should be planted:
    - West River - Weston along Route 100
    - West River and Grassy Brook in Brookline and Newfane
    - Williams River - Chester and Rockingham
    - Lower Saxtons River and Bull Creek
    - Along the mainstem of CT River and its tributaries including Sacketts and East Putney Brooks
- Work with farmers to complete conservation assessments to find out what tools and resources are available using NRCS's CART (Conservation Assessment Ranking Tool)
- Target outreach to young / new farmers to link these farms with assistance providers
- Determine sources of high nutrients in the Williams River near Chester/Rockingham line and Sacketts Book
- Encourage participation in the NRCS Conservation Stewardship Program (CSP) to identify natural resource problems and receive technical and financial assistance to solve problems in an environmentally beneficial and cost-effective manner.
- Support local agricultural partners to provide outreach, education, and technical assistance to farms throughout the Basin

B. Developed Lands

Stormwater

Stormwater runoff from developed lands, including the road network, is one of the greatest threats to water quality in Vermont. Stormwater runoff is any form of precipitation that flows over the land during or after a storm event or because of snowmelt.

On undeveloped lands a majority of the water is absorbed into the ground through infiltration while the remainder takes a relatively slow path into nearby rivers, lakes, and ponds. On developed lands,

however, infiltration is reduced by impervious surfaces such as roads, rooftops, and driveways, this additional runoff picks up and carries pollutants into rivers and lakes and increases the volume and velocity of runoff water. This ultimately leads to an increased frequency and intensity of flooding as well as a greater likelihood that runoff will become contaminated with pollutants. Increased erosion and property damage, degraded aquatic and terrestrial habitats, and threats to public health via recreational contact and contaminated drinking water are often the result.

This section integrates basin-specific information on stormwater-related water resource impairments, regulatory programs, Stormwater Master Plans (SWMP), Illicit Discharge Detection and Elimination (IDDE) studies, existing implementation efforts and partnerships to inform strategies to address stormwater-related water resource impairments.

Developed lands cover just 5.6% of the Basin, the majority of which is roads. More developed areas of the Basin include Brattleboro, Bellows Falls, Stratton, Winhall and Chester. Developed lands contribute 12% of the nitrogen load from this Basin to Long Island Sound. This is the largest portion of human-caused nitrogen being discharged. The runoff has also exacerbates the *E. coli* impairment on the West River in South Londonderry.

The tactical basin planning approach engages local, regional, and federal partners in the development of strategies needed to accelerate adoption and monitoring of stormwater related BMPs to meet the state's clean water goals including reductions to support the Long Island Nitrogen TMDL. Voluntary stormwater efforts through stormwater master planning are likely to be the primary drivers for stormwater implementation efforts for this planning cycle.

General Permit 3-9050 (Three-Acre General Permit)

General Permit 3-9050 is a permit regulating stormwater runoff from impervious surfaces except for public roads. It is an important component of the Vermont Clean Water Act of 2015 (Act 64) and is designed to assist in the implementation of clean-up efforts in Lake Champlain, Lake Memphremagog, and stormwater-impaired waters, while also protecting high quality surface waters statewide.

This general permit covers all operational stormwater permitting, including new development, redevelopment, and permit renewal. The general permit serves as, and is often referred to as, the "Three-Acre General Permit" as required under the Vermont Clean Water Act. Additionally, the thresholds for stormwater construction permitting are being reduced to one-half acre of impervious surface on July 1, 2022.

There are no stormwater impaired watersheds in this Basin. Parcels with 3 or more acres of impervious cover in the Connecticut River watershed, including Basin 11, will need to apply for permit coverage by 2033. Since this date is well beyond the timeframe for this plan, voluntary stormwater efforts through stormwater master planning are likely to be the primary drivers for stormwater implementation efforts for this planning cycle.

Stormwater Mapping and Master Planning

Stormwater infrastructure mapping projects are completed for municipalities by the Vermont Clean Water Initiative Program to supplement the existing drainage data collected by towns and with the intention of providing a tool for planning, maintenance, and inspection of the stormwater infrastructure. Stormwater mapping reports were completed for significant areas of 17 towns in Basin. (Table 13) providing 24 Stormwater Mapping Reports or Stormwater Master Plans (SWMP).

The reports and maps from each project are meant to provide an overall picture and understanding of the connectivity of the storm drainage system on both public and private properties to raise the awareness of the need for regular maintenance. These reports identify potential priority projects in the study areas and provide information necessary to develop a SWMP. The highlighted projects can be completed separately or in conjunction with the development of a SWMP.

Projects identified as high priority in the Stormwater Mapping Reports may be implemented by towns with the aid of Regional Planning Commissions or other partners where necessary. Towns with significant development should consider developing a SWMP, while a multi-town SWMP can be developed for smaller towns. One SWMPs has been completed for Crosby Brook in Brattleboro and one Water Quality Remediation Plan (WQRP) is in place for Stratton Resort. The remainder of Brattleboro and Bellows Falls/Westminster are recommended for SWMP development. All towns with Stormwater Mapping Reports and High Priority projects identified can determine which projects they can pursue and move towards completing single or batch preliminary designs for those projects.

Table 12. Towns with completed stormwater mapping reports and the number of high priority projects identified
Click on the town to access the reports.

Town Name	Year Completed	Number of High Priority Projects Identified
Brattleboro	2010	38
West Brattleboro	2017	8
Crosby Brook	2015	22
Chester	2019	7
Dover	2019	19
Mt Snow Ski Area (WQRP)	2019	12
Dummerston	2019	1
Grafton	2019	0
Jamaica	2017	2
Town Name	**Year Completed**	**Number of High Priority**

		Projects Identified
Londonderry	2017	6
Marlboro	2017	2
Newfane	2017	1
Peru	2017	2
Putney	2017	4
Putney School	2017	0
Landmark College	2017	3
Greenwood School	2017	0
Rockingham	2017	11
Vermont Academy	2017	0
Stratton (WQRP)	1999	0
Townshend	2017	3
Wardsboro	2017	4
Westminster	2017	2
Kurn Hattin	2017	0
Weston	2017	3
Winhall	2017	4

The Vermont Green Infrastructure Toolkit is a clearinghouse of information useful to Vermont municipalities to explore how to promote the adoption of Green Infrastructure policies and practices to combat the problems caused by urban, suburban, and rural stormwater runoff.

Illicit Discharge Detection & Elimination Studies

Additionally, VDEC implements a statewide program to detect and eliminate improper or illegal discharges into stormwater drainage systems. Illicit discharges are wastewater or industrial process water releases into a stormwater-only drainage system. Three IDDE reports have been completed and are listed in Table 13.

Table 13. Illicit Discharge Detection & Elimination Reports

Click to access to reports.

Town IDDE Report	Year Completed
Illicit Discharge Detection and Elimination in Brattleboro	2012, 2019
Detecting and Eliminating Illicit Discharges in Basin 11	2020

Several of the discharges identified in Brattleboro have been addressed.

Since 2016 over $1.62 million dollars in state grants and loans have been invested in implementing or preparing to implement stormwater improvement projects in the Basin.

Table 14. State Investment and Outcomes of Stormwater Improvement Projects

Project Development & Output Measures	Prior Yrs	SFY 2018	SFY 2019	SFY 2020	Total
Number of illicit/unauthorized discharges confirmed		2			2
Number of projects identified through Stormwater Master Plans	4		1	3	8
Number of projects identified through River Corridor Plans	5				5

Clean Water Goals for Stormwater

- Priority areas for implementation of stormwater improvement projects include: Crosby Brook, Ball Mountain Brook, Chester, Bellows Falls and Brattleboro
- Develop and implement SWMPs for these communities
- Implement treatment recommendations in the town Stormwater Reports

Roads

Runoff from roads can increase stormwater volume and pollutant levels and the extensive gravel roads in this basin runoff is a significant source of sediment. Road infrastructure can also impinge on stream floodplains and be a barrier to aquatic organism passage (AOP) with undersized culverts.

The Municipal Roads General Permit (MRGP) is a general permit for discharges of regulated stormwater from municipal roads. This permit is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. Regulated stormwater from municipal roads covered by the permit include Class 1-4 town highways and their rights-of-ways and municipal stormwater infrastructure associate with town highways.

Towns are required to bring 15% of non-compliant or partially-compliant hydrologically connected road segments identified in a Road Erosion Inventory (REI) into compliance with MRGP drainage standards by December 31, 2022. Very High Priority connected segments are to be brought up to standards by December 31, 2025 and all road types, except for Class 4 roads, by December 31, 2028. All Partially and Not Meeting scoring segments are required to meet standards by December 2036. The implementation of the priorities identified in REI's will reduce sediment, phosphorus, and other pollutants such as metals, road salt and hydrocarbons associated with stormwater-related erosion generated from unpaved municipal roads that contribute to water quality degradation.
Road Erosion Inventories are required of all Vermont municipalities to identify sections of local roads that do not meet MRGP road standards and are in need of sediment and erosion control practices. These assessments rank road segments to prioritize those that pose the highest risks to surface waters. Required remediation practices include road crowning, lowering of road shoulders, grass- and stone-line ditching, and upgrading driveways, drainages, and intermittent stream culverts.

These practices disconnect and re-direct road stormwater into vegetated areas before entering waterways. Where disconnection and infiltration are not possible, practices focus on stabilizing the conveyances. The MRGP also requires any bare soils within municipal hydrologically connected segments to be stabilized with vegetation and or stone-lining within 5 days of disturbance. REI results by town can be viewed in the MRGP Implementation Table.

With the assistance of the Regional Planning Commissions, all of the towns in the Basin, except Peru, have completed REIs (Figure 22).

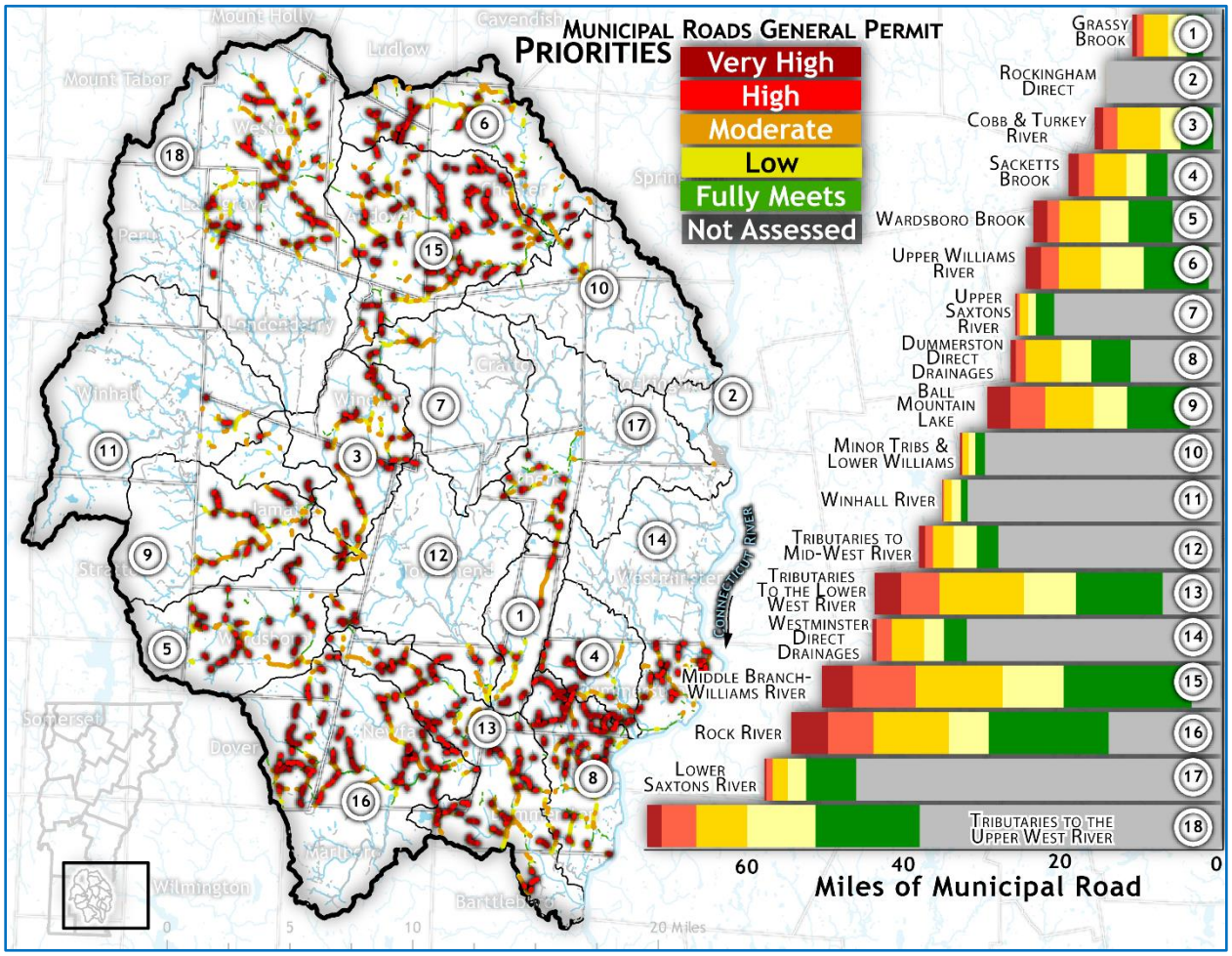


Figure 22. Priority Roads for Project Implementation Based on REI's as of November 2020.

Resources available from the Clean Water Fund (e.g., AOT Grants-in-Aid, VDEC Small Equipment grant, and AOT Better Roads grants) assist with development of designs, capital budgets, cost estimates and implementation of road projects. Completion of these projects may be counted towards meeting the requirements of the MRGP. For additional information on the MRGP see the DEC Municipal Roads Program.

Most towns rely heavily on the AOT and WRC for technical support in meeting MRGP standards. These organizations have joined together as the "Rivers and Roads Workgroup" to provide a forum

to discuss outreach, technical and financial assistance, cost sharing opportunities, targeted trainings, and to identify gaps in service and assistance needs in communities.

In addition to the MRGP, all but five towns in the Basin have voluntarily adopted the most current version of the Vermont Road and Bridge Standards. These standards are administered by AOT and go above and beyond MRGP standards. For example, municipalities may adopt MRGP standards for non-hydrologically connected roads. Towns adopting the Vermont Road and Bridge Standards, coupled with other requirements, may be entitled to higher State cost share rates in federally declared flood event reimbursements.

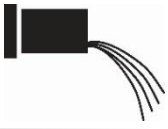
Since 2016 over $2.91 million dollars in state grants and loans have been invested in implementing or preparing to implement road improvement projects in the Basin.

Table 15. State Investment and Outcomes of Road Improvement Projects

Project Development & Output Measures	SFY 2017	SFY 2018	SFY 2019	SFY 2020	Total
Number of municipal road drainage and stream culverts replaced	2		7		**9**
Miles of municipal road drainage and erosion control improvements	1	5	9	4	**18**
Hydrologically connected municipal road miles inventoried	15	48	38	61	**162**
Hydrologically connected municipal road miles identified that require water quality improvements	12	28	20	36	**95**
Cubic yards of Class IV road gully erosion remediated		44			**44**

Clean Water Goals for Roads

- Complete the upload of REI results for all towns to the MRGP Implementation Table database
- Prioritize technical and financial assistance to interested towns based on the water quality benefit of a project targeting segments that Do Not Meet and Partially Meet MRGP standards
- Implement priority practices in target watersheds including the towns and sub-watersheds of the Upper West River in Weston, Ball Mountain Brook; Marlboro Branch and Townshend in the West River watershed; the Middle and South Branches Williams River; Grafton in the Saxtons River Watershed; and Morse Brook (Westminster) and Sacketts Brook (Putney) in the Connecticut Direct drainage
- Conduct outreach on private roads and driveway BMPs using the newly developed VDEC Private Road REI protocols.
- Implement erosion projects on Class 4 roads & legal trails to address Very High Priority non-MRGP compliant segments on slopes greater than 10%.



C. Wastewater

Wastewater Treatment Facilities (WWTF)

Unlike the other sectors described in this chapter, wastewater discharges represent a regulated and readily measurable and controlled source of pollutants to waters in the state. Potential pollutants from wastewater discharges include bacteria and pathogens and nutrients. There are four municipal and one industrial wastewater treatment facilities (WWTF) that are subject to National Pollutant Discharge Elimination System (NPDES)discharge permits in the Basin (Table 17).

An overarching consideration for the issuance of permits in the Basin is the Long Island Sound TMDL for nitrogen. This multi-state Total Maximum Daily Load (TMDL) has been promulgated with interim wasteload and nonpoint source nitrogen load allocations. As of the issuance of this Plan, all facilities are implementing a wasteload allocation plan and permitting strategy devised by the Watershed Management Division (WSMD) in all Connecticut River direct discharges to account for the new nitrogen (N) limitations to meet an interim total Vermont load of 1,727 lbs. N/day.

Table 16. Wastewater Treatment Facilities and other Facilities Subject to NPDES Direct Discharge Permits

Facility	Permit expiration date	planned permit re-issuance	Design Flow	IWC 7 Q10/LMM	Treatment Type	receiving water
Bellows Falls	9/30/2021	2021	1.4	0.002/0.001	RBC	CT River
Chester	3/31/2020	2021	0.175	0.082/0.024	SBR	Williams River
Putney	9/30/2021	2021	0.1	0.113/0.041	extended aeration	Sacketts Brook
Putney Paper (Soundview)	12/31/2017	2021	0.275	0.0005/0.0001	primary clarification/activated sludge	CT River
Saxtons River	12/31/2022	2023	0.105	0.042/0.012	SBR	Saxtons River

Design Flow in million gallons per day

Facility-specific information

Bellows Falls

The Bellows Falls facility consists of headworks, two primary settling tanks, three trains of Rotating Biological Contactors (RBCs), two secondary clarifiers, and a chlorine disinfection tank. There are three anaerobic digesters and one sludge holding tank on site along with a belt filter press. Since 2017 the clarifiers, three anaerobic digesters, pumps and the chemical room have all been upgraded.

Chester

The Chester WWTF was last upgraded in 2006 when the treatment process was upgraded to SBRs followed by ultraviolet disinfection prior to the effluent being discharged to the Williams River. Sludge produced at the facility is wasted from the SBRs to a rotary drum thickener then stored in an aerated holding tank prior to being disposed of offsite.

Putney

The Putney WWTF provides secondary treatment using extended aeration activated sludge process followed by chlorination and dechlorination. Effluent is discharged to Sackett's Brook at the deepest section of stream. There are four pump stations within the collection system. Upgrades to the facility

occurred in 2006 whereby an additional secondary clarifier was added, new chlorine contact chambers were constructed and the aeration system was upgraded.

Saxtons River

The Saxtons River WWTF was constructed in 1972 and consisted of an oxidation ditch, secondary clarifier, and chlorine contact tank. In 2019, the facility replaced the oxidation ditch and chlorine disinfection system with a fine screen, aerated grit removal system, two Sequencing Batch Reactors (SBRs), UV disinfection, and an equalization basin. In September 2019, construction at the WWTF was completed and deemed operational. The outfall pipe associated with the original wastewater treatment infrastructure was abandoned in 2019. A new outfall pipe with two valves was installed upstream of the original outfall in 2019 to accommodate river channel evolution caused by Tropical Storm Irene.

Initial sampling in April of 2020 showed a 3-fold reduction in effluent Total Nitrogen as compared to before the reconstruction.

Soundview Vermont Holdings, LLC (Putney Paper)

This facility is involved in the production of tissue and napkin paper grades with 100% secondary wastepaper deink process. Wastepaper is pulped with sodium hydroxide and the slurry goes through various stages of washing, cleaning and screening prior to the papermaking process. The treatment of process wastewater consists of primary clarification followed by a two-stage high activated sludge treatment process. Sludge from the two-stage aeration/clarification system from the primary clarifier is wasted to a belt filter press for dewatering and is disposed of offsite. Treated wastewater is discharged through a several thousand foot long, six-inch pipe to the Connecticut River.

The Soundview discharge permit is currently being drafted with the intent to be issued in late 2021.

Septic Systems

Municipal wastewater treatment discharges contribute approximately 1% of the Basin's delivered aggregate nitrogen load to Long Island Sound. Of greater concern is the estimated 9% contribution entering from individual and multi-unit on-site septic systems.

Inadequate or poorly maintained on-site septic systems can leach pollutants to surface waters. If a system is not functioning correctly and leachate is directly entering waters, recreational users may be exposed to high bacteria levels. Potentially disease-causing organisms and nutrients can move through the soil to the river or lake. This can happen under several conditions including when the soil below the leachfield is too shallow or too porous and leachate quickly joins the groundwater. This may not be visible above-ground.

The State of Vermont adopted universal jurisdiction over the design, permitting, and installation of all new wastewater disposal systems and potable water supplies including septic systems in 2007. All new wastewater disposal systems and potable water supplies must obtain a Wastewater System and Potable Water Supply Permit for activities such as: subdivision of land; construction of a new building that needs a wastewater system (often referred to as sewage disposal or a septic system) or water supply; and repair and/or replacement of a failed wastewater system or water supply. Wastewater systems that have wastewater surfacing, backing up into the building or discharging to the waters of the State are considered failed systems. A permit is also required when there is an existing wastewater disposal system and/or potable water supply but there will be an increase in water or wastewater design flows due to either a modification to, or a change in use of, a connected building.

Systems installed before July 1, 2007, and systems installed or receiving increased flows after 2007 that did not receive a permit could potentially discharge into surface waters if the system was not installed correctly and is located in close proximity to a river, lake, or wetland. Failed or poorly functioning systems can contribute *E. coli*, phosphorus, or nitrogen to surface waters. Failed systems that discharge pollutants into surface waters are difficult to identify without landowner permission and there is no current regulatory tool that requires inspections of pre- or post-2007 wastewater systems on a regular basis unless specified in their permit. If a citizen observes signs of a failed septic system, they should contact their Town Health Officer. There are programs that provide financial assistance to qualifying homeowners that need to upgrade their systems, but costly upgrades prevent many homeowners from upgrading their systems.

There are a number of historic villages in the Basin adjacent to rivers that do not have treatment facilities and where on-site septic systems are likely the source of elevated levels of contamination to surface water.

DEC provides direct funding and technical assistance to small communities without municipal treatment to help evaluate and plan for wastewater needs. It is anticipated there will be a steady demand by several small communities for wastewater evaluations and planning in the coming years. These communities have not been identified in the past as being the sources of surface water pollution, but residents are now realizing that they may have problems with their small lot and older on-site sewage systems in the event of a system failure that must be replaced or when upgrades are needed for property re-sale. Another factor is the economic viability of small communities which cannot support commercial or residential growth due to the lack of wastewater treatment options.

Momentum has been growing in rural villages to explore options to deal with concerns about pollution from septic systems and growth in village centers that result in a need for centralized shared wastewater systems. Alternative treatment systems are available to communities not wishing to build large waste treatment facilities, including several advanced technologies for small community scale systems that have been approved for use in Vermont.

The Vermont Engineering Planning Advance Program is a loan program available to municipalities without existing municipal water or sewer systems for conducting a feasibility study for community based drinking water and/or wastewater solutions. Consulting engineers assess the town's needs and goals offering treatment options that can include:

- Soil-Based, Small Scale, Incremental Wastewater Disposal Systems
- Sewer extension to a nearby wastewater collection system
- Decentralized community wastewater disposal systems
- Cluster septic systems
- Waste diversion systems
- Media filters
- Aerobic treatment systems
- Composting toilets

The Village Wastewater Solutions Initiative offers these resources for further information:

- Organizing Village Wastewater Solutions
- Wastewater Solutions for Vermont Communities

An example of a decentralized wastewater disposal systems can be found in a demonstration project in the town of Warren, Vermont, which was reported to the USEPA as a different approach for managing wastewater in rural villages.[30] Areas with elevated *E. coli* levels like the Connecticut River could benefit from this type of approach. Funding is the most common barrier to identifying and remediating *E. coli* sources, however recently available American Rescue Plan Act (ARPA) funding may be a resource for helping to address this issue. People are also concerned about reporting or putting financial strain on their neighbors with potentially failing systems.

A recent addition to these alternative treatment systems is Urine Diversion, the practice of keeping human urine separate from the rest of the wastewater stream for use as an agricultural resource. Separation and sanitation of urine keeps these nutrients from causing water pollution, reduces the need for large-scale treatment facilities, conserves drinking water and reclaims and recycles the nutrients for plant growth.

Urine contributes approximately 80% of the nitrogen in wastewater. Separating urine at the source is therefore a simple way to remove the majority of nitrogen from wastewater, which in turn reduces nitrogen loading to ground and surface waters. Rich Earth Institute has conducted a feasibility study with two Basin communities to assess, at a neighborhood scale, the feasibility of innovative

[30] Warren, Vermont: A Different Approach for Managing Wastewater in Rural Villages, Stone Environmental, Inc., 2005.

wastewater solutions to respond to septic system challenges and to facilitate compact village development in Vermont. [31]

> The Village Sanitation Pilot Study (VSPS) was a collaborative wastewater planning effort to explore environmentally sound and practical wastewater solutions in Vermont villages. This partnership between the Rich Earth Institute, the Windham Regional Commission, and Nutrient Networks engaged neighbors in two villages in the Windham Region (Westminster West and West Dummerston) to assess, at a neighborhood scale, the feasibility of innovative wastewater solutions to respond to septic system challenges and to facilitate compact village development in Vermont.
>
> Many state and local planning goals in Vermont aim to focus growth in compact village centers. However, the majority of village centers rely on individual on-site (septic) systems to handle wastewater treatment and disposal. Due to challenging site conditions, many villages are unable to expand or add new septic systems. This means it can be difficult or impossible to renovate or construct new buildings, which impedes the goal of compact development. Septic systems can also impact both environmental and public health by releasing nutrients and pathogens to groundwater. Climate change may exacerbate each of these challenges while also increasing growth pressure on villages. This study was the first to comprehensively assess the possibility of eco-sanitation options to help address village wastewater challenges in Vermont.[32]

Septic Socials

Concerns around failing septic systems is especially important in rivershore communities. One way to inform people about the health of their systems is to host a septic social. Septic socials are neighborhood gatherings where homeowners learn about the options for a well-functioning septic system and good maintenance practices, including household products that are kind to septic systems. The event provides an informal opportunity for people who may never have seen a septic system to learn about them and their importance to water quality protection. A septic system specialist discusses operation and maintenance of septic systems using the host homeowner's system as the demonstration model. Attendees are provided with brochures and other resource materials to take home. Septic socials are best for areas with old septic systems that may be having an impact on water quality. More information about septic socials can be found at: http://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise/lake-wise-septic-system-socials.

Table 17. State Investment and Outcomes of Municipal Wastewater Projects

Project Development & Output Measures	SFY 2016	SFY 2017	SFY 2018	SFY 2019	Total
Number of final (100%) designs completed	1				**1**
Number of municipal wastewater asset management plans completed		2		1	**3**
Number of wastewater collection systems refurbished			1		**1**

[31] Village Sanitation Pilot Study, Rich Earth Institute, 2020
[32] Ibid.

Clean Water Goals for Wastewater

- Reduce the nitrogen load from municipal wastewater discharges which are estimated to account for 9% of Vermont's total discharge to the Connecticut River
- Conduct planning and feasibility studies for small communities without wastewater systems
- Upgrade wastewater facilities for nitrogen reduction
- Increase the availability of the Clean Water State Revolving Fund programs to meet statewide wastewater control needs, including Long Island Sound nitrogen control needs through loans to individuals.
- Encourage communities to invest in protection of future water supply source waters
- Host septic socials in riverfront communities including Weston, Londonderry, Jamaica, and Grafton

D. Natural Resources

Natural resource projects restore ecological functions of natural infrastructure. Forests, lakes, ponds, rivers, floodplains and wetlands are all examples of natural infrastructure that provide continuing benefits both socially and ecologically. Natural resources restoration projects help to prevent and reduce nutrient and sediment pollution, improve flood resiliency by mitigating flood hazards, enhance habitat function, and support Vermont's outdoor recreational opportunities.

Economically, restoration and protection of natural infrastructure offers a cost-effective, long-term means to mitigate water quality and the effects of climate change and enhances the ecosystem services these natural resource provide.

The World Bank has long invested in these nature-based solutions to natural disasters and watershed degradation:

> Natural systems have long provided many of the services communities seek from grey infrastructure — protection from natural hazards and provision of key resources such as water and energy.
>
> Nature-based solutions (NBS), … can provide a cost-effective and flexible approach for disaster risk and water resource management.[33]

[33] Nature-based Solutions: a Cost-effective Approach for Disaster Risk and Water Resource Management

The Nature Conservancy also promotes nature-based solutions "to support robust economic development, improve the quality of life in communities and sustain America's lands and waters for future generations." [34]

Rivers

Rivers are in a constant balancing act between the energy they produce and the work that must be done to carry the water, ice, sediment, and woody material produced in their watersheds. A change in any one of these factors will cause adjustments of the other variables until the river system comes back into equilibrium (balance). These changes can be caused by natural events and by human activity. These actions can disrupt the balance by changing flow inputs to the channel (such as by deforestation, increasing impervious surfaces and runoff, or water withdrawals) or by changing sediment regime (such as with dams, dredging, or in response to intensified erosion).

This section includes basin specific information on how to improve all aspects of river connectivity - longitudinally, laterally, vertically, and temporally to support stream equilibrium and riparian habitat. In simple terms, a connected river is a river that freely flows from upstream to downstream, freely meanders and exchanges water with lands, vegetation, and waterbodies alongside its path, freely accesses its floodplain, and freely cycles through its flow pattern with the seasons. Restoring river connectivity is essential for good water quality, healthy aquatic habitat, and flood resilience in the basin and will help to mitigate impacts of increased runoff and streamflow described in the climate change section.

Stream Geomorphic Assessments

There is limited coverage of Phase I or Phase II Stream Geomorphic Assessments (SGAs) in the Basin. As evidenced in Figure 12 the Basin's rivers are overall in Fair to Poor geomorphic condition. Historic channel manipulation, steep slopes and confined valleys leading into alluvial floodplains with encroaching development, along with more recent uncontrolled channel work following Tropical Storm Irene compound to degrade conditions.

The goal of managing toward, protecting, and restoring the equilibrium condition of Vermont rivers is to resolve or avoid conflicts between human investments and river dynamics in a manner that is technically sound, and both economically and ecologically sustainable. In addition, it will help to mitigate impacts of increased runoff and streamflow from climate change.

SGAs and the resulting River Corridor Plans provide extensive lists of restoration projects to restore watershed conditions. The higher priority projects are entered into the Watershed Projects Database. By far the most numerous projects proposed are for floodplain and stream restoration followed by river corridor protection and riparian planting.

[34] *Natural Infrastructure, Effective, Economical and Sustainable Solutions to Meet America's Needs*, TNC, 2020.

Priority projects in this Plan will focus on restoring geomorphic conditions by protecting vulnerable and valuable floodplains and river corridors from further encroachment, removing berms along waterways, better managing river/road conflicts to reduce erosion and removing unused dams. Strategies vary from assisting municipalities with establishing zoning bylaws to protect river corridors, FEMA mapped flood hazard areas, and riparian areas from future encroachment to physically lowering the level of adjacent land to allow floodwaters to access the floodplain.

Beyond geomorphic conditions, water quality and habitat improvement projects are also being pursued including stemming and restoring eroded land and gullies, riparian planting for bank stability and temperature moderation, and removal of obsolete dams.

The Williams River, the upper and lower West River and the lower Saxtons River watersheds are focal areas for natural resource restoration projects.

Since 2016 over $1.92 million dollars in state grants and loans have been invested in implementing or preparing to implement natural resource restoration projects in the Basin.

Table 18. State Investment and Outcomes of Natural Resource Projects

Project Development & Output Measures	SFY 2016	SFY 2017	SFY 2018	SFY 2019	SFY 2020	Total
Acres of floodplain restored					0	**0**
Acres of forested riparian buffer restored through buffer planting	2	1	2	1	0	**6**
Acres of forestland conserved with water quality protections		16	5		26	**47**
Acres of riparian corridor conserved and restored through easements		14				**14**
Acres of river corridor scoped for easement				27		**27**
Miles of forest road drainage and erosion control improvements					3	**3**
Number of final (100%) designs completed		1			1	**2**
Number of natural resources restoration project identified		1		14		**15**
Number of preliminary (30%) designs completed	1			10		**11**
Number of stream crossings improved					6	**6**
Stream miles reconnected for stream equilibrium/fish passage			20		3	**23**

Dams and Dam Safety

There are 49 known dams in the Basin and likely many more that have not been documented. Each known dam is categorized by the status of its use or condition. For a complete listing and map of known dams see Appendix C.

Dams are rated for their hazard potential. The hazard potential classification of the dam is based on the potential loss of human life, property damage, and economic loss that would occur in the event of the failure of the dam. These ratings are High, Significant, Low and Minimal. A number of dams have already been breached. Table 19 shows the hazard class of the Basin's 49 dams.

Table 19. Dams by Hazard Class

Hazard Class	# of Dams
High	5
Significant	7
Low	31
Minimal	0
Breached	6
TOTAL	43

Five dams and one dam-like structure have been removed from the Basin since publication of the previous Plan:

- Bagatelle Dam, Dummerston, unnamed tributary to the West River
- Kidder Hill Dam, Grafton, South Branch Saxtons River
- Magic Mountain Dam, Londonderry, Thompsonburg Brook
- Weston Lower Dam, Weston, Cold Spring Brook
- Tucker Reed Rd Dam, Dummerston, Crosby Brook
- Concrete crossing, Andover, Trout Brook

All these removals were done in partnership with local, regional, state and federal partners. Only one of these dams was mapped and documented prior to removal.

All dams, even small dams for backyard ponds, are significant structures that can have major public safety and environmental implications. As a result, dams are regulated by a variety of federal, state and local laws. Beyond its regulatory authority, the state also has considerable interest in working with dam owners to see that dams are safe by being well maintained and responsibly operated. The information provided is to help dam owners and prospective dam owners to understand the implications of owning, maintaining and operating a dam.

Enacted in 2018, Act 161 - An Act Relating to the Regulation of Dams,[35] gave VDEC jurisdiction to regulate non-federal dams that do not produce power. Jurisdiction includes dam registration, classification, inspection, application and approval to construct, re-construct, alter, repair, breach, or remove a dam, as well as related standards including design standards, operation and maintenance standards, inspection standards, and emergency action plans. It establishes dam owner liability and responsibility for the safe management and operation of their dam, and compliance with the rule.

Flood Control & Hydro Power Dams

Flood control dams on the West River at Ball Mountain and Townshend are operated to reduce flood damages downstream of the dams and to reduce damages collectively along the entirety of Connecticut River. This service has prevented many millions of dollars in flood damage from occurring from Vermont to Connecticut.

[35] 10 V.S.A. Chapter 43

These benefits come with environmental costs, however. These include blocking fish passage, disrupting the continuity of stream flow and sediment, warming the water, and unnatural fluctuations in flow levels and velocity.

The Army Corps West River white-water recreational releases that occur in the spring and fall have been an area of concern since 2014 when the Corps discontinued following the the 2004 flow agreement with the US Fish and Wildlife Service and VANR. . The flow management during these events has caused fish stranding as evidenced by surveys conducted by VFWD (see Appendix E.c.).

In 2004 the USACE, US Fish and Wildlife Service and VANR reached agreement regarding operations of these dams geared to improving stream habitat conditions in the West River including modifications to minimum flows and ramping rates during whitewater releases. This agreement meant to "maintain and restore the integrity of the downstream and upstream aquatic and terrestrial ecosystems while maintaining the projects' primary purpose of flood control and recognizing other recreation and natural resource management objectives" when fully implemented. A key part of the process is the annual interagency coordination meeting, to be held in January of each year., which should be re-instituted along with conservation flow, ramping release rates, and reservoir release/refill standards for flood control operations so as to reduce the ecological impacts of shifting flow rates, dramatic water level fluctuations and the unnatural timing of high-water events. VDFW has documented fish stranding due to rapid water level decreases when flow is shut down following whitewater release.

Past operations offered whitewater releases for recreational boaters in both the spring and fall conducted to lower the pool levels for winter and offer more favorable flows for migrating fish. The release limits are based on USFWS Aquatic Base Flow standards to provide more consistent conservation flows downstream. Releases have varied between spring and fall and just fall events. Agreement of the number and timing of events has not been achieved.

While boating enthusiasts continue to express concern regarding the limited release schedule and its impact on recreation and the local economy, questions remain on the ecological impact of shifting the timing of high water in the spring when flows are consistently high.

An additional recreation concern at Townshend Reservoir is the accumulation of sediment in Townshend Lake. The depth of sediment has made use of the lake impossible. USACE dredged the beach area of the lake in 2015 only to have it rapidly refilled during numerous high-water events.

For an extensive discussion of the questions and concerns regarding whitewater releases and information on the Coordination Plan between the State and USACE see Appendix E.a.

Two hydroelectric power dams on the Connecticut River, at Bellows Falls and Vernon, have similar environmental impacts as do flood control dams. These dams also impact the migration of anadromous shad and American eel and can kill fish as they move through the generating turbines. Managing for safe fish passage upstream and downstream, and stabilizing flow rates are being addressed in the relicensing process the dams are undergoing.

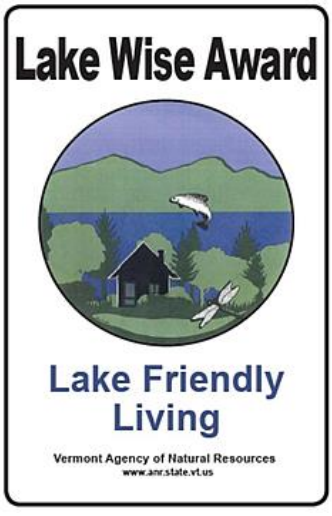
Connecticut River Aquatic Invasives

There is growing concern about spreading populations of riverine aquatic invasives throughout the Connecticut River particularly associated with boat launches. Eurasian watermilfoil, water chestnut, hydrilla, curly leaf pondweed, European Naiad/European water nymph, Japanese knotweed, phragmites/common reed, purple loosestrife, yellow flag iris, and flowering rush are all documented along the river. Gaining a full understanding of the extent of these invasives, tracking and working to prevent further spread and undertaking control where necessary is needed.

Clean Water Goals for River Restoration

- Continue the removal of dams wherever possible
- Complete a geomorphic assessment and River Corridor Plan for the upper West River
    - Prioritize projects that address sediment and erosion for implementation
- Plant or expand riparian buffers throughout the Basin
- Continue working toward river equilibrium by increasing floodplain access and protections
- Focus restoration work on reaches with High to Extreme Sensitivity ratings
- Re-establish the flood control dam partnership to implement the operations agreement
- Survey, monitor, and address aquatic invasive species on the Connecticut River and throughout the Basin

Lakes



The Shoreland Protection Act[36] of 2014 regulates shoreland development within 250 feet of a lake's mean water level for all lakes greater than 10 acres in size. This shoreland zone is critical to preventing degradation of water quality in lakes, preserving habitat and natural stability of shorelines, and maintaining the economic benefits of lakes and their shorelands. The Act seeks to balance good shoreland management and appropriate shoreland development. Shoreland developed prior to 2014 is not required to retroactively meet standards.

The Lake Wise Program is an initiative that encourages lakeshore owners to implement practices that improve and protect lake water quality conditions and habitat. The Lake Wise Award certifies a

[36] 10 V.S.A. § 1441

property is well managed, using shoreland Best Management Practices, and is maintained to care for the lake.

Cole Pond and Stratton Pond are currently the only lakes monitored through the Lay Monitoring Program.

Clean Water Goals for Lake Restoration

- Lake Wise outreach and technical assistance is a priority for Wantastiquet Lake, Cole Pond and Sunset Lake (Marlboro).
- Continued monitoring is recommended for Stratton Pond to determine the cause of the significantly increasing total phosphorus concentrations. Interestingly, this pond also has significantly decreasing chlorophyll-A trends. It is unusual to see the two trends heading in opposite directions.
- Establishing a boat access Greeter Program at Gale Meadows Pond, the only lake in the Basin with a known population of Eurasian watermilfoil, at Lowell Lake, and at Townshend Reservoir to help prevent further spread.
- Establishing Lay Monitoring programs on Lowell Lake, Gale Meadows, Kenny Pond, and Sunset Lake.
- Recommendations for lake restoration include:
    - Townshend Reservoir – sediment management
- Of the 23 lakes currently being monitored for Total Phosphorus, Total Nitrogen, Secchi transparency and Chlorophyll-a only Lowell Lake has a complete set of data. Of the remaining 88 data points 76 are listed as Insufficient Data. Increased monitoring of the Basin's lakes is recommended.

Wetlands

Wetlands effectively attenuate nonpoint source pollution, mitigate flooding, and stabilize streams and rivers. The protection and restoration of wetlands and floodplain forests is one strategy that has been adopted to protect and improve water quality. While conservation and protection of wetlands are critical for preventing continued loss of remaining intact wetlands, wetland restoration is essential for rehabilitating those that have already been degraded or lost. Wetland restoration is the process of returning a degraded wetland to an approximation of its pre-disturbance condition.

The Vermont Natural Resources Conservation Districts have received state funding to assist in mapping pocket wetlands throughout the state.

Clean Water Goals for Wetland Restoration

- Work toward accurate mapping of wetland resources, including vernal pools
- Fully assess high quality wetlands for reclassification to Class I

- Provide technical assistance to municipalities in adopting local zoning ordinances that may afford wetlands further protection
- Recommendations for wetlands restoration include:
    - Herrick Cove - Rockingham
    - Henwood Hill Road Marsh - Westminster
    - Retreat Meadows - Brattleboro
    - Sand Hill Road - Putney
    - Agricultural fields along Rt 100 north of village - Weston

Fisheries

Cold-water and warm-water fishereis in the Basin are managed by the Fishereies Section of the VDFW who work to implement management actions to improve and enhance aquatic communities.

Clean Water Goals for Fisheries Management

1. **Protect and restore riparian corridors** – Undisturbed, naturally vegetated buffer strips are extremely important in maintaining cool water temperatures and stable streambanks, filtering pollutants and providing food and shelter for fish and other aquatic organisms. These benefits are realized not only within the protected stream reach, but also in its downstream receiving waters. Providing outreach and education to private landowners on the benefits of riparian corridors would also benefit streams and should be promoted. Restoring riparian corridors and controlling invasive species at site specific projects should also be considered.

2. **Improve aquatic habitat connectivity** – Maintaining a connected system allows fish to seek the best available habitat for reproductive needs, food resources, thermal refuge, and cover. Aquatic connectivity also allows for the recolonization of upstream habitats after catastrophic events, such as floods or toxic discharges. Furthermore, free movement within a river system helps to maintain genetic diversity of aquatic populations.

3. **Improve flood resiliency and restore post-Irene impacts** – Post-Tropical Storm Irene impacts, including berming, instream channelization, and removal of instream cover including boulders and wood inevitably impacted aquatic biota within the Basin 11 watersheds. Restoring instream complexity and access to floodplains would improve the overall quality of the system, leading to positive impacts on fish populations (Kirn 2012). Efforts should be made to identify sites and restore these reaches back to natural conditions. Examples include removing berms along Route 35 in Grafton.

4. **Where flows are regulated, promote the natural flow regime** – Maintaining or improving flow management at hydroelectric, storage, and existing flood control facilities would benefit downstream species. Rapid fluctuations in flows can strand fish or displace them

downstream. Fluctuations may also expose or destroy spawning areas containing eggs or newly hatched fish.

5. **Stop the spread of exotic species and pathogens** – A variety of non-native fish species and harmful pathogens are present in Vermont or surrounding states. Preventing future introductions of these exotic species and pathogens will allow healthy fisheries to continue.

6. **Protect water quality** – Maintaining clear, cold, and well-oxygenated water is an important habitat requirement for trout. Activities that can have negative impacts to water quality (i.e. sediment discharges), should be avoided and/or minimized through evaluation of proposed projects. Additional efforts by interested partners to work with private landowners on riparian land stewardship will compliment state and federal regulatory efforts. Ski resorts should continue efforts to restore impaired waters.

7. **Identify and designate B(1) High Quality Fishing** – For Wild Salmonid Streams abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (Brook, Brown, or Rainbow trout) at levels generally equal to or greater than 1,000 fish/mile and/or 20 pounds/acre. Streams designated as B1 are provided increased protection. Based on VTFWD data, streams that meet the B1 criteria include Baker Brook, Dover Brook, Fair Brook, Farnum Brook, Greendale Brook, Pike Hollow Brook, Rock River, Utley Brook, Waite Brook, Andover Branch, Canoe Brook, East Putney Brook, Morse Brook, and Salmon Brook.

Forests

Forests are the best form of land use for sustaining water quality and quantity. Studies clearly show that the amount of forestland within a watershed is an indicator of water quality and healthy aquatic ecosystems. In urban areas, trees and forests are part of what is referred to as the community's "green infrastructure" and help reduce stormwater runoff. In rural areas, forests protect municipal water supplies, mitigate the impacts of flooding, replenish groundwater aquifers, and provide recreation and critical fish and wildlife habitat, as well as a variety of wood products.[37]

Forested areas provide multiple watershed benefits including their ability to help mitigate impacts from flooding. Forests intercept, evaporate, transpire, and infiltrate rainwater and snowmelt. They have the infiltrative capacity to absorb water, releasing it gradually, thus moderating streamflow. The forest floor is a critical watershed attribute of forested watersheds. The forest floor is composed of the litter layer, underlying organic layer, and fibrous roots. It controls storm runoff, stream sedimentation, and nutrient loading by encouraging surface water to infiltrate into the soil.[38]

[37] Desired Future Condition: Forest Products and Ecosystem Services, Vermont ANR, 2017
[38] Ibid

Timber harvesting can directly influence water quality by affecting how water flows through a forest. Constructing roads, trails, and log landings can reduce soil permeability, increase soil erosion, and divert and concentrate water flow, leading to gullying. Concentrated water flow can erode streambanks and put undue pressure on bridges and culverts. Best management practices (BMPs) are voluntary, proactive, practical methods or practices used during forest management to achieve a healthy sustainable ecosystem with a focus on water quality, forest soils, silviculture, wildlife, biodiversity, aesthetics, and recreation. In Vermont, the water quality practices are called "Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont" (AMPs). The purpose of the AMPs is to provide measures for loggers, licensed foresters, and landowners to utilize, before, during, and after logging operations to comply with the Vermont Water Quality Standards under the Federal Clean Water Act and to minimize the potential for a discharge from logging operations in Vermont.[39]

The AMPs, which are legally enforceable rules required for Vermont land to comply with the Federal Clean Water Act, contain preventative measures to help control soil erosion and protect water quality. The AMPs are designed to minimize the effects of logging on the natural hydrologic functions of forests. The guidelines discuss how to absorb or disperse runoff, retain soil nutrients, filter sediment, prevent fluctuations in water temperature, and contribute organic material to surface waters. In place since 1987, the AMPs were revised in 2016 as a requirement of Act 64 with an improved set of practices to improve the water quality in Vermont.[40]

Forests cover 89% of the land area in the Basin. 16% is State, Federal or municipally owned, 84% is privately owned of which 40% is managed under the Use Value Appraisal or Current Use Program which is set up to keep land in forest cover. Figure 23.

Maintaining or enhancing forest cover in the watershed should be a primary strategy in the Basin.

[39] Desired Future Condition: Forest Products and Ecosystem Services, Vermont ANR, 2017
[40] Ibid

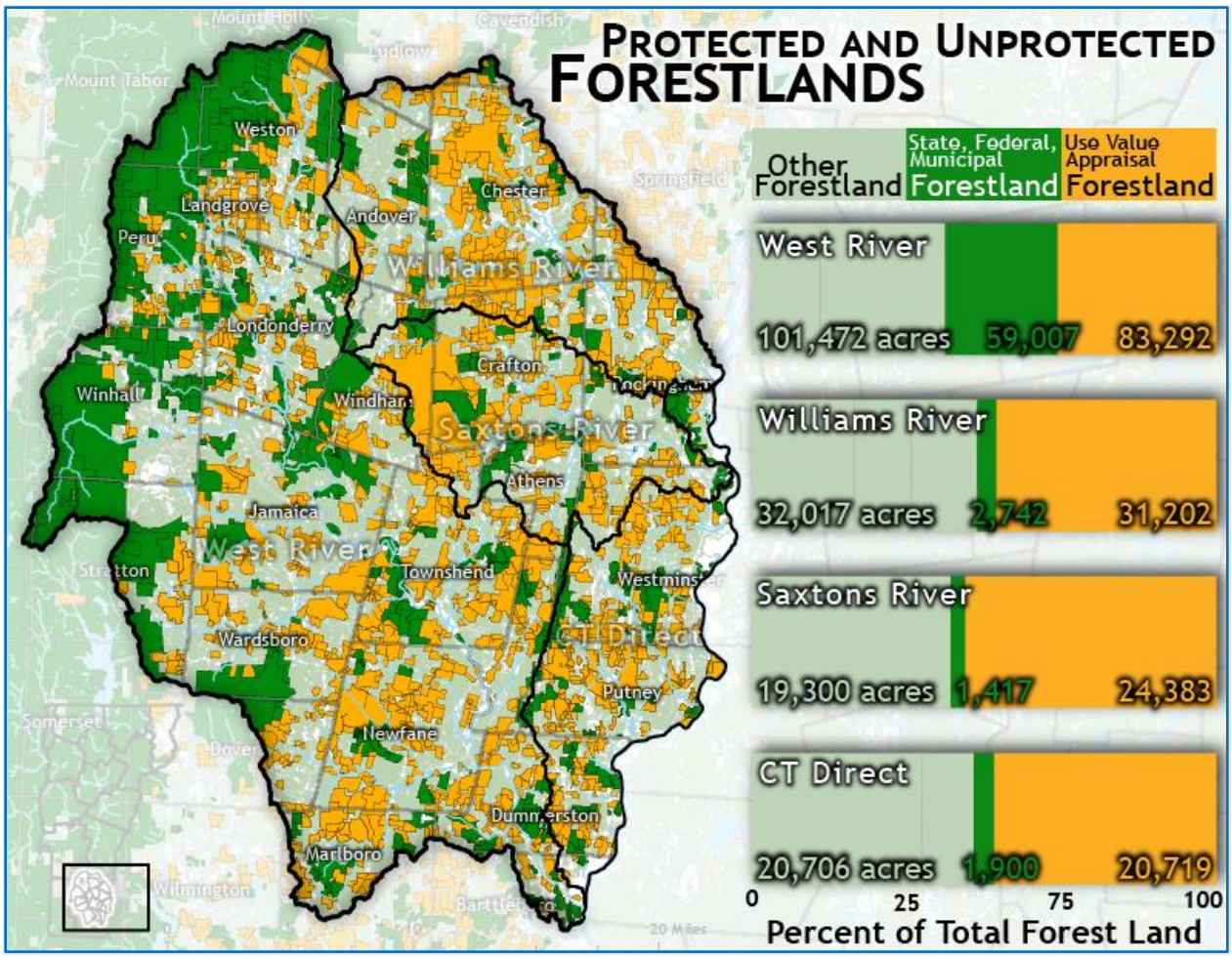


Figure 23. Protected Forest Cover

Clean Water Goals for Forest Restoration

- Expand the skidder bridge program to make them more available to loggers
- Prevent stream erosion and improve resiliency on working lands through riparian restoration; logging road restoration; and stream crossing improvements which include installing properly sized structures or structure removal
- Protect forest habitat for water quality protection, biodiversity, and drinking water sources

Climate Change Adaptation

The anticipated effects of a warming climate have particular implications for this Basin. A number of species occur only in the southern Connecticut River valley. Some reach the northern limit of their range here making the Connecticut River an important corridor for the northern migration of species responding to climate change pressures such as increasing temperatures, increasing drought, food web disturbances, habitat degradation and others. Habitat protection for these species will be

critical to their long-term survival. Forested riparian buffers provide corridors for wildlife to access otherwise fragmented habitats as they adjust to climate pressures.

The number one goal of the Vermont Wildlife Action Plan is to:

- Conserve, restore, and enhance habitats, natural plant and animal communities, and ecosystem integrity to maintain suitability for SGCN and ecological function and to improve resiliency to climate change.

And the Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems[41] states:

- *The more intensive population growth found in the northern Champlain Valley, and the population growth, less conserved land, and greater road density found in portions of central Vermont and the southern Connecticut River valley result in higher potential block fragmentation threats in these areas.*

Another priority in the Wildlife Action Plan is:

- *A priority conservation strategy identified in the Wildlife Action Plan was to "Identify and prioritize, for conservation, existing contiguous forest blocks and associated linkages that allow for upward and northward movement (of species) in response to climate change."*

Of particular concern for this Basin and identified in the Wildlife Action Plan as priorities for conservation:

Fowlers Toad (*Bufo fowleri*) was listed as Endangered in 2015. It is a Species of Greatest Conservation Need in Fluvial Habitat. The Fowler's Toad is very rare and has been found only in the southern Connecticut River Valley. It prefers naturally disturbed shorelines.

Spotted Turtle (*Clemmys guttata*) found in limited locations in Windham, Bennington and Addison counties has a state natural heritage rank of S1 (very rare). The Spotted Turtle has been designated a Species of Greatest Conservation Need (high priority).

North American Racer (*Coluber constrictor*) (snake) currently found only along the southern Connecticut River, has a state natural heritage rank of S1 (rare). The North American Racer is threatened in Vermont and has been designated a Species of Greatest Conservation Need (high priority).

Eastern Box Turtle (*Terrapene carolina*) in Vermont are generally assumed to be released pets, however a cluster of reports from the southern Connecticut River Valley suggest the possibility of a native population.

[41] Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems, VT DFW, 2014

American Shad (*Alosa sapidissima*) in Vermont, is restricted to the Connecticut River from the Massachusetts line upstream to at least Bellows Falls dam. In 2020 over 362,000 shad migrated past the Holyoke Dam in Massachusetts but only 1,745 were counted passing the Vernon Dam into Vermont with none reaching Bellows Falls.[42]

American Eel (*Anguilla rostrata*) – Connecticut River population – Eel management in the Connecticut River is currently focused on construction of eelpasses (to enable upstream juvenile eel movement around dams) and enumeration of immigrating eels.[43]

Eastern Pearlshell Mussel (*Margaritifera margaritifera*) is found in the West River and is listed as threatened in Vermont.

Brook Floater Mussel (*Alasmidonta varicosa)*, with the only known population in Vermont found in the lower West River, is listed as endangered in Vermont.

Impacts to Humans and the Built Environment

Beyond consideration of wildlife migration, the coming changes are predicted to initiate human migration out of more vulnerable coastal, southern and western regions, where flooding, fire and temperature risks are expected to be greatest, into areas projected to be more resilient to these impacts. In New England, Maine and Vermont are rated by EPA as being at the lowest risk of climate impacts.[44]

Gathering evidence of this movement, compounded by the exodus of people from densely populated areas seeking to retreat from congested metropolitan areas due to the COVID-19 pandemic indicates this migration is already underway.

Based on data from The Vermont Real Estate Market Reports comparing December 2019 to December 2020, home sales in Vermont have increased 32% and the average sales price by 22%. Housing inventory has dropped 71%.[45] While it is too early to determine if these increases will continue or if the new homeowners are full or part time or short or long term residents, the added pressure of this influx may have broader repercussions on the environment for forest fragmentation, land use conversion and water quality. Municipal services may see impacts as well from increasing demand for water and wastewater, to demand for housing, food and recreational resources.

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[42] CONNECTICUT WEEKLY DIADROMOUS FISH REPORT, June 30, 2020 (preliminary)
[43] Vermont Wildlife Action Plan
[44] Summers, J. K., et al. Development of a Cumulative Resilience Screening Index (CRSI) for Natural Hazards: An Assessment of Resilience to Acute Meteorological Events and Selected Natural Hazards, EPA600/R-20/274, 2020.
[45] Vermont Association of REALTORS, Vermont Indicators Report December 2020

More analysis of these trends should be conducted and state, regional and municipal planning should begin examining and planning for the potential impacts.

Clean Water Goals for Climate Change Adaptation

- Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN
- Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels
- Conserve and manage known habitat through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management
- Continue to document and monitor species distribution and relative abundance in Connecticut River Valley with targeted searches of potential sites, and sites where previously reported
- Map species habitat including connectivity of patches
- Work to maintain connectivity with populations to the south in Massachusetts and across the Connecticut River to New Hampshire
- Identify wetlands most able to provide carbon sequestration function, including marginal agricultural wetlands that may be restored
- Work with municipalities to understand and begin planning for the potential influx of human climate migrants
- Implement best management practices that improve forest and agricultural soil health to improve resiliency to climate change.

Hazard Mitigation and Flood Resiliency

Act 16, passed by the Vermont Legislature in 2014, requires municipal and regional plans to incorporate a "flood resilience" component into all future plans. Working towards resiliency means both proactively reducing vulnerabilities to flooding and flood damage and improving response and recovery efforts when flood events do occur, so that communities bounce back quickly and minimize long term economic, social, and natural resource impacts. The effort has led to the creation of maps to identify local flood hazard areas, identifying specific areas that should be protected for their values of slowing down or attenuating floodwaters (including floodplains, river corridors, forests and wetlands) and recommending specific strategies and policies that will help protect these areas and reduce the risks facing existing development. VANR is providing resources and assistance to make flood resiliency an integral part of town planning including river corridor

maps and model language for town and regional plans and local zoning ordinances. Numerous Tactical Basin Plan actions will assist communities in becoming more flood resilient.

Financial incentives for municipalities have been established in accordance with the requirements of 10 V.S.A. §§ 1427 and 1428 for the adoption and implementation of municipal zoning bylaws that protect and preserve river corridors, shorelands and buffers. Communities become eligible for financial incentives for river corridor and floodplain protection based on a rating system that considers a suite of mitigation activities, including implementation of Standard River Management Practices. Emergency Relief and Assistance (ERAF) rules now recognize towns that have increased river corridor and floodplain protection and provide an increased state cost share for emergency relief funding.

The Emergency Relief and Assistance Fund provides State funding to match Federal Public Assistance after federally-declared disasters. Eligible public costs are reimbursed by federal taxpayers at 75%. For disasters after 2014, the State of Vermont will contribute an additional 7.5% toward the costs leaving the municipal share of 17.5%. For communities that take specific steps to reduce flood damage the State's contribution will increase to 12.5% or 17.5% of the total cost.

The four mitigation measures towns must have in place to receive 12.5%:

1. National Flood Insurance Program (participate in or have applied to);
2. Town Road and Bridge Standards – (annually certify adopted standards that meet or exceed the standards in the most current: VTrans Orange Book: Handbook for Local Officials);
3. Local Emergency Operations Plan (adopted annually after town meeting);
4. Local Hazard Mitigation Plan - adopt a FEMA- approved local plan (valid for five years).

To receive 17.5% - eligible communities also must:

5. Protect River Corridors from new encroachment; or, protect their flood hazard areas from new encroachments and participate in the FEMA Community Rating System. After a declared disaster, the damage to public infrastructure including roads and culverts can exceed a million dollars. Adoption of these resiliency measures can mean significant savings for municipal taxpayers.

Figure 24. Emergency Relief and Assistance Fund Cost Share per $1 Million
From: https://floodready.vermont.gov/find_funding/emergency_relief_assistance

Figure 24 demonstrates, in the event of $1,000,000 in damages to infrastructure, the municipal share of recovery costs will decrease by up to $100,000 when ERAF protections are in place.

Four towns in the Basin have completed this process and will receive the maximum 17.5% State match for future damages. These are Marlboro, Putney, Windham and Winhall. Thirteen towns have reached the 12.5% match rate and eleven towns remain at the 7.5% rate. An updated list can be found at Flood Ready Vermont.

Clean Water Goals for Hazard Mitigation and Flood Resiliency

- Work with municipalities to adopt floodplain and river corridor protections to achieve greater ERAF funding levels.
- Work with municipalities to complete Hazard Mitigation Plans and Emergency Operations Plans.
- Work toward stream equilibrium in all restoration efforts
- Decrease stormwater inputs that exacerbate peak flows
- Prioritize hazard mitigation and corridor protection projects on the Middle Branch Williams River and the Saxtons River.

Watershed Planning and Social Equity

The State of Vermont is committed to advancing equity and environmental justice for all those who live, work, recreate, and learn in Vermont. State agencies are crafting budgetary and programmatic proposals that align with these values and meet individual and shared goals. Through data-informed program design and careful consideration of compounded historical inequity,

Conservation Science Partners (CSP), in partnership with the Hispanic Access Foundation (HAF) and the Center for American Progress, produced the report *The Nature Gap: Confronting Racial and Economic Disparities in the Destruction and Protection of Nature in America*[46] "which provides an initial assessment of demographic disparities in the concentration and distribution of nature. According to this study 76% of lower income communities in Vermont live in areas identified as nature-deprived as compared to 46-50% of middle and high income communities.[47]The data reveal substantial differences in the degree of nature deprivation faced by different racial, ethnic, income, and family structure groups."[48]

[46] Rowland-Shea, Jenny, Doshi, Sahir, Edberg, Shanna, and Fanger, Robert, The Nature Gap: Confronting Racial and Economic Disparities in the Destruction and Protection of Nature in America, July 21, 2020
[47] Ibid
[48] Ibid

Ensuring clean surface water for consumptive and recreational uses, ensuring fish caught in Vermont are safe for consumption, ensuring access to waters for all abilities and in all communities, providing open space availability in more densely populated areas and ensuring clean water projects are equitably implemented in all communities are areas where tactical basin planning can work toward equity and environmental justice.

Tactical Basin Planning Goals for Improving Social Equity and Environmental Justice

- Identify and prioritize water quality improvement projects that offer the following co-benefits:
    - Clean surface water for consumptive and recreational uses
    - Safe consumption of fish caught in Vermont
    - Access to waters for recreation for all abilities and in all communities
    - Open space availability in more densely populated areas
    - Equitable implementation of clean water projects in all communities
- Monitor fish tissue toxin concentrations to protect populations dependent on subsistence fishing
- Incorporate open space options into urban restoration projects
- Seek opportunities to increase access to waterbodies where access is known to be limited or non-existent
- Work with indigenous communities to protect culturally significant resources

Chapter 5 – The Basin 11 Implementation Table

A. Progress in Basin 11

The Tactical Basin Plan addresses all impaired, stressed, and altered waters in the basin as well as protection needs for high quality waters. The list of strategies in the Implementation Table (Table 20) and the Monitoring and Assessment Table (Table 21) cover future assessment and monitoring needs, as well as projects that protect or remediate waters and related education and outreach.

The Implementation Table provides a list of 97 priority strategies created with the intention to be used as the go-to guide in the first step toward watershed action. A list of related individual project entries is found in the online Watershed Projects Database (WPD). The projects vary in level of priority based on the strategies outlined in the summary. All projects in WPD are not expected to be completed over the next five years, but each action in the summary is expected to be pursued and reported upon in the following plan and updated in the WPD.

As projects are developed, priority for Clean Water Initiative Program funding will be given to those projects that achieve the highest water quality benefits. Additionally, projects that provide cumulative benefits (i.e., flood resiliency, water quality improvement, water resource protection, aquatic organism passage) will receive additional consideration for prioritization.

The 2015 Basin plan identified 68 action items for implementation. Fifty-seven (84%) have been implemented or are in progress by ANR and its watershed partners, two are under discussion and have been carried over to this plan, one have been discontinued and 8 have not begun. (Figure 25). A report card for each of these strategies can be viewed in Appendix A.

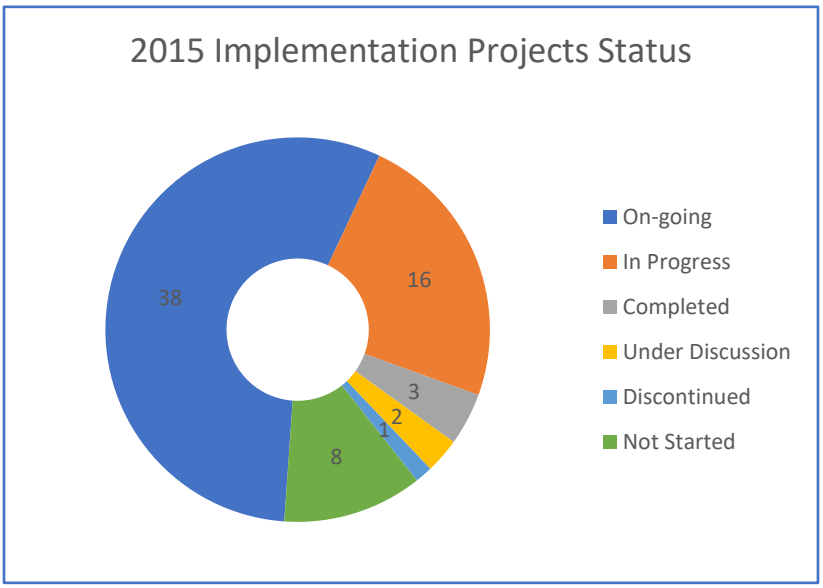


Figure 25. Status of Priority Strategies Identified in the 2015 Plan

This Tactical Basin Plan builds upon those previous plan recommendations by promoting specific, geographically explicit projects in areas of the basin that have been identified for intervention, using environmental modeling and on-the-ground monitoring and assessment data where available.

B. Coordination with Watershed Partners

Partnerships are crucial in carrying out non-regulatory projects to improve water quality. There are several active organizations undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in the Basin. These partners are non-profit, private, regional, state and federal organizations working on both private and public lands. The Windham and Mount Ascutney Regional Commissions, the Ottauquechee and Windham County Natural Resources Conservation Districts, US Fish and Wildlife Service and Forest Service, Connecticut River Conservancy (CRC), Southeastern Vermont Watershed Alliance, Saxtons River Watershed Collaborative, Trout Unlimited Chapters, lake associations, and municipal groups including local conservation commissions are active in:

- providing outreach and education to local stakeholders, private landowners, and municipalities;
- developing stream and floodplain protection and restoration projects (e.g., river corridor easements, tree plantings, culvert and bridge upgrades, dam removals, stream channel habitat restoration);

- developing stormwater projects (e.g., SWMPs, road erosion inventories, implementation of town road BMPs); and
- monitoring water quality (e.g., lay monitoring program on lakes, *E. coli* and nutrient monitoring in rivers).

Partners active in working with farms in the basin developing and implementing BMPs for water quality include USDA Natural Resource Conservation Service (NRCS), VT Agency Agriculture Food and Markets (VAAFM), the conservation districts, CRC and the University of Vermont Extension Service.

The large amount of work that is necessary to meet water quality targets in this basin require collaborations among all these groups to maximize the effectiveness of watershed partners. Without funding or partners, little of this work would be possible.

C. Basin 11 Implementation Table

The process for identifying priority strategies is the result of a comprehensive compilation and review of both internal ANR monitoring and assessment data and reports, and those of our watershed partner organizations. The monitoring and assessment reports include, but are not limited to, stormwater mapping reports, geomorphic assessments, river corridor plans, bridge and culvert assessments, Hazard Mitigation Plans, agricultural modeling and assessments, road erosion inventories, biological and chemical monitoring, lake assessments, fisheries assessments, and natural communities and biological diversity mapping.

A summary of priority strategies to address water quality in the Basin are identified in Table 1. The summary is the guiding list to go to as a first step for watershed action. The strategies can be linked to the on-going detailed list of projects in the online Watershed Projects Database.

The following tables serve to identify high priority implementation strategies and tasks that provide opportunities for all stakeholders in surface water management across each major river basin to pursue and secure technical and financial support for implementation. For these priorities to be achieved, partners and stakeholders must help to carry out the strategies identified in the basin plan.

Table 21, the Implementation Table Summary, provides a summary of strategies and actions to address water quality priorities by sector.

Table 20.

Summary of Implementation Actions

Strategy	Priority Areas / Watershed	Town	Partners	Funding
AGRICULTURAL LANDS				
Continue outreach and technical assistance through workshops and trainings for farmers, ag contractors and technical service providers on the RAPs, improving soil health, implementing conservation field practices and financial assistance resources	Basin-wide		NRCDs, AAFM, NRCS, UVM Ext., CRWFA	ACWIP, TBPSG
Connect basin farmers with the Connecticut River Watershed Farmers Alliance to facilitate information sharing and regional workshops and involvement with this organization	Basin-wide		NRCDs, AAFM, NRCS, UVM Ext., CRWFA	ACWIP, TBPSG
Provide education and technical assistance related to Nutrient Management Planning development and implementation, focusing on nutrient application rates and timing, management strategies for excessive soil phosphorus levels, record keeping, and field BMPs that improve soil health and water quality. Prioritize waterways that are listed as stressed due to sediment and agricultural field runoff	Westminster Direct Drainages, Williams River, lower Saxtons River, upper West River	Chester, Rockingham, Weston, Londonderry	NRCDs, AAFM, NRCS	ACWIP, EQIP, CSP, RCPP
Support implementation of farmstead BMPs, such as silage leachate management and waste storage facilities, to reduce agricultural production area runoff to nearby surface waters	Westminster Direct Drainages, Williams River, lower Saxtons River, upper West River		NRCDs, AAFM, NRCS	ACWIP, EQIP, CSP, RCPP

Increase riparian forested buffer establishment on agricultural land along surface waterways and wetlands	> West River - Weston along Route 100 > West River and Grassy Brook in Brookline and Newfane > Williams River - Chester and Rockingham > Lower Saxtons River and Bull Creek > CT River mainstem and Sacketts and East Putney Brooks		NRCDs, AAFM, NRCS, FSA	ACWIP, EQIP, CSP, RCPP, TFS, BBG, CREP
Provide technical assistance to small farms to provide RAP education and resources to assist them in understanding and meeting water quality requirements of the RAPs, including identify and register farms of size for Certified SFO	Basin-wide		UVM Ext., NRCDs, AAFM, NRCS	TBPSG
Target outreach to young / new farmers to link these with assistance providers	Basin-wide		UVM Ext., NRCDs, AAFM, NRCS, CRWFA	ACWIP, TBPSG
Determine sources of high nutrients in the Williams River near Chester/Rockingham line	Williams River	Chester, Rockingham	VDEC, AAFM, NRCS, NRCDs,	CWIP, WG
Encourage participation in the NRCS Conservation Stewardship Program (CSP) to identify natural resource problems and receive technical and financial assistance to solve problems in an environmentally beneficial and cost-effective manner	Basin-wide		NRCDs, AAFM, UVM Ext., NRCS, CRWFA	TBPSG

Strategy	Priority Areas / Watershed	Town	Partners	Funding
DEVELOPED LANDS / STORMWATER				
Conduct stormwater master planning to identify and prioritize actions	West River, Saxtons River, Ball Mountain Brook, Williams River	Brattleboro, Bellows Falls/No. Westminster, Stratton/Winhall, Chester	RPCs, NRCDs, municipalities, ski resorts	CWIP, Municipal Planning Grant
Implement priority project identified in municipal Stormwater Infrastructure Mapping Reports and SWMPs	Crosby Brook & above	Brattleboro, Bellows Falls/No. Westminster, Stratton/Winhall, Chester	RPCs, NRCDs, municipalities,	CWIP, CWSRF, LIS-FF
Identify and mitigate sources of bacteria causing impairment	West River, Sacketts Brook	Londonderry, Putney	VDEC, municipalities	CWSRF, CWIP
Address stormwater runoff discharges and water withdrawal impacts from ski area development impacting water quality	Ball Mountain Brook, Mill Brook	Jamaica, Peru, Winhall	ski resorts	
Continue to track the progress of project implementation of Stratton WQRP the to address stormwater impacts	Ball Mountain Brook	Jamaica	ski resorts	
Conduct outreach to the real estate industry on the economic benefits of clean water and on applicable wetland and stormwater rules	Basin-wide		NRCDs, RPCs	TBPSG, WG
DEVELOPED LANDS / ROADS				
Assist municipalities to control runoff from gravel and paved roads: implement road assessment protocol to assist with prioritization; and comply with the Municipal Roads General Permit (MRGP)	Basin-wide		RPCs, NRCDs, VAOT municipalities	TBPSG, BR, GIA
Complete the upload of REI results for all towns to the database	Basin-wide		RPCs, municipalities	BR
Prioritize technical and financial assistance to interested towns based on the water quality benefit of a project targeting segments that Do Not Meet and Partially Meet MRGP standards	Basin-wide		RPCs, VDEC	BR, GIA

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Implement priority practices in target watersheds	Upper West River in Weston, Ball Mountain Brook; Marlboro Branch and Townshend in the West River watershed; the Middle and South Branches Williams River; Grafton in the Saxtons River Watershed; and Morse (Westminster) and Sacketts (Putney) in the Connecticut Direct drainage			VAOTMAB, GIA, BR, Structures, CWIP
Implement erosion projects on Class 4 roads & legal trails to address Very High Priority non-MRGP compliant segments on slopes greater than 10%	Basin-wide		NRCDs, municipalities	BR, GIA, CWIP
Increase municipal participation in BR & GIA funding: assist in project prioritization and project proposal development	Basin-wide		RPCs, NRCDs, municipalities, VDEC	TBPSG
Encourage municipal DPW participation in VT Local Roads and Rivers & Roads trainings	Basin-wide		RPCs, NRCDs, municipalities, VDEC	TBPSG
Assist the Town of Landgrove in relocating the sand storage area out of the floodplain	Utley Brook	Landgrove	VDEC	
Conduct outreach on BMPs for private roads and driveways	Basin-wide		RPCs, NRCDs	TBPSG, WG
Replace geomorphologically incompatible culverts and bridges	Basin-wide		VTrans, municipalities	Structures
WASTEWATER				
Reduce the nitrogen load from municipal wastewater discharges to address the LIS-TMDL	Basin-wide		Municipalities	CWSRF
Conduct village wastewater studies and wastewater planning for small communities without municipal systems	Basin-wide	Weston, Londonderry, Jamaica, Grafton Newfane	VDEC	CWSRF

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Examine bacteria loads upstream of known swimming and fishing locations as part of wastewater studies to protect health and safety	Basin-wide	Weston, Londonderry, Jamaica, Grafton, Newfane, Putney, Saxtons River	VDEC	CWSRF
Increase funding of the Clean Water State Revolving Fund programs to meet statewide wastewater control needs, including Long Island Sound nitrogen control needs	Basin-wide		VDEC	CWSRF
Upgrade wastewater facilities for nitrogen reduction	Basin-wide		Municipalities	CWSRF
Host septic socials in riverfront communities		Weston, Londonderry, Jamaica, Grafton, Newfane	Municipalities	CWSRF
Encourage communities to invest in protection of future water supply source waters	Basin-wide		VDEC	FEMA, CWSRF
NATURAL RESOURCE RESTORATION: Rivers, Lakes, Wetlands & Forests				
Increase education and outreach on natural resource restoration and protection needs and opportunities	Basin-wide		ALL	CWIP, WG, TBPSG
Incorporate aquatic resources into VDFW's Community Mapping protocols			VDFW	
RIVERS: Work toward stream equilibrium and flood resilience				
Increase the number of river and floodplain restoration projects to re-establish connections to floodplains	Reaches with High to Extreme Sensitivity ratings		NRCDs, RPCs	CWIP, WISPr
Increase River Corridor Easements which incorporate channel management, riparian buffers, wetlands, and flood resiliency to afford protection from conversion & development	Basin-wide		VRC, VLT, TNC	CWIP, VHCB, WISPr

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Plant or expand riparian buffers throughout the Basin	Basin-wide		NRCDs, watershed assoc	CWIP, WISPr, WG
Address sediment and/or nutrient issues causing Stressed and Impaired listings	Lower Williams and lower Saxtons Rivers, Crosby Brook		VDEC, NRCD	CWIP, WISPr
Identify and address sources of bacteria	Lower Sacketts Brook		VDEC, watershed assoc	WISPr, WG
Complete a geomorphic assessment and River Corridor Plan for the upper West River	upper West River		WRC, CRC	ERP
^ > Prioritize projects that address sediment and erosion for implementation				CWIP, WISPr, WG
Remove dams, esp. High Hazard dams	Basin-wide		CRC, RPCs, dam owners	ERP, WISPr
	> Blake-Higgens Dam	Westminster		
	> Williams Dam	Londonderry		
Develop an Aquatic Nuisance Species (ANS) Management Plan for the entire CT River to facilitate the coordination of ANS early detection, rapid response, and management efforts throughout the watershed and provide opportunities for state and federal cost sharing programs	Entire Basin		VDEC, NHDES, SEVT CISMA, CRC, CRJC	USFWS Aquatic Nuisance Species Task Force
Develop a CT River Public Access Greeter Program at boat launches for the entire CT River to initiate an aquatic nuisance species spread prevention effort that includes education, outreach, and watercraft boat inspections			VDEC, NHDES, SEVT CISMA, CRC, CRJC	ANCGIA
Continue Aquatic Nuisance Species (ANS) monitoring within the entire CT River Basin and specifically within the tri-state regional of VT, NH, and MA to survey for, and manage any threats of new or existing aquatic invasive species expansion or introduction within the regional border location			VDEC, SEVT CISMA, CRC, CRJC	ANCGIA

Strategy	Priority Areas / Watershed	Town	Partners	Funding
LAKES: protect and restore				
Promote & Implement the Lake Wise Program to encourage lake-friendly shoreline property maintenance	Wantastiquet Lake, Cole Pond, Sunset Lake		lakeshore owners, lake assoc, NRCDs, VDEC-Lakes	CWIP, ERP, WISPr
Establish Lay Lake Monitoring on appropriate lakes and ponds	Lowell Lake, Gale Meadows, Kenny Pond, Sunset Lake		lakeshore owners, lake assoc, VDEC-Lakes	WG
Establish a boat access Greeter Program	Gale Meadows Pond (the only lake in the Basin with a known population of Eurasian watermilfoil); Lowell Lake and Townshend Reservoir)to help prevent further spread)		lakeshore owners, lake assoc, NRCDs, VDEC-Lakes	WG
Monitor Stratton Pond to determine the cause of increasing nutrients	Stratton Pond		VDEC-Lakes	
Implement projects to mitigate sediment accumulation in Townshend Lake	Townshend Lake		USACE, VDEC, Municipalities	CWIP, WG
Work to control riparian and aquatic invasive plants	All Lakes & ponds		lakeshore owners, lake assoc	AIS GIA
Monitor lakes to fill gaps in the data record	Lakes lacking data		VDEC-Lakes	

Strategy	Priority Areas / Watershed	Town	Partners	Funding
WETLANDS: protect and restore				
Restore degraded wetlands for habitat and water quality improvement, and flood resiliency	Basin-wide		AAFM, VDEC, NRCS NRCDs, watershed assoc,	CWIP, DU, WISPr, NRCS
Assess areas of managed wetland and hydric soils for restoration	Agricultural fields along Rt 100 north of village - Weston		AAFM, VDEC, NRCDs, watershed assoc	WG, DU, WISPr
Implement wetland restoration as sites and opportunities are identified	Herricks Cover - Rockingham; Henwood Hill Road Marsh - Westminster; Retreat Meadows - Brattleboro; Sand Hill Road - Putney		GRH, VDEC, NRCS, NRCDs, watershed assoc,	CWIP, DU, WISPr, NRCS
Assess high quality wetlands to support reclassification to Class I	see Table 8		VDEC – Wetlands, watershed assoc, Conservation Commissions	
Update mapping of wetlands	Basin-wide		VDEC - Wetlands, RPCs, NRCDs	
FISHERY: protect and restore				
Protect and restore riparian corridors	Basin-wide		TU, VDFW, USFS, NRCDs, watershed assoc	CWIP, TU, WG, EBTJV, WISPr

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Improve aquatic habitat connectivity	Basin-wide		CRC, TU, VDFW, USFS, NRCDs, watershed assoc	CWIP, TU, WG, EBTJV, WISPr
Improve flood resiliency and restore post-Irene impacts	Basin-wide		TU, VDFW, USFS, NRCDs, watershed assoc	CWIP, TU, WG, EBTJV, WISPr
Where flows are regulated, promote the natural flow regime	Basin-wide		VDEC, VDFW	
Identify and designate B(1) High Quality Fishing	Baker Brook, Dover Brook, Fair Brook, Farnum Brook, Greendale Brook, Pike Hollow Brook, Rock River, Utley Brook, Waite Brook, Andover Branch, Canoe Brook, East Putney Brook, Morse Brook, and Salmon Brook			
Control current and prevent future introductions of these exotic species and pathogens to protect healthy fisheries	Basin-wide, Herricks Cove, Retreat Meadows		CRC, TU, VDFW, USFS, NRCDs, watershed assoc	ANS Grant
FOREST MANAGEMENT: protect and abate soil erosion				
Protect headwater streams and sensitive upland surface waters	Basin-wide		DFPR, USFS, VLT	USFS, WISPr, CWIP
Protect and restore riparian corridors	Basin-wide		VDEC, VDFW, VRC	CWIP, WISPr

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Protect forest habitat for water quality protection, biodiversity, and drinking water sources	Basin-wide		VDEC, VDFW, USFS, VRC	CWIP, WISPr
Conduct outreach on AMPs and forest BMPs	Basin-wide		DFPR, NRCDs	WQ Planning
Prevent stream erosion and improve resiliency on working lands through riparian restoration; logging road restoration; and stream crossing improvements which include installing properly sized structures or structure removal	Basin-wide		DFPR, landowners, loggers	CWIP, WG, WISPr
Expand the skidder bridge program to make use of these more convenient for loggers	Basin-wide		NRCDs	WG
CLIMATE CHANGE ADAPTATION: mitigate potential impacts of climate change on species survival				
Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN	Basin-wide		ANR, RPCs, NRCDs, USFWS	
Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels	Basin-wide		VDFW	
Conserve known habitat of SGCN through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management	Basin-wide		ANR, land trusts, USFWS	SWG, CWIP, WISPr, VHCB
Continue to document and monitor species distribution and relative abundance in Connecticut River Valley with targeted searches of potential sites, and sites where previously reported	Basin-wide		VDFW	
Map species habitat including connectivity of patches	Basin-wide		VDFW	
Work to maintain connectivity with populations to the south in Massachusetts and across the Connecticut River to New Hampshire	Basin-wide		ANR, RPCs, NRCDs, USFWS	SWG, CWIP, WISPr, VHCB

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Increase practices that sequester carbon for the long term	Basin-wide		ANR, USFWS	

HAZARD MITIGATION & FLOOD RESILIENCY				
Work with municipalities to adopt floodplain and river corridor protections to achieve greater ERAF funding levels	Basin-wide		VDEC-Rivers, RPCs	TBPSG
Work with municipalities to complete Hazard Mitigation Plans and Emergency Management Plans	Basin-wide		VEM, VDEC-Rivers	FEMA, MPG
Prioritize hazard mitigation and corridor protection projects on the Middle Branch Williams River and the Saxtons River	Middle Branch Williams River, Saxtons River		VEM, FEMA, RPCs	FEMA, HMP, PDHMP
Work toward stream equilibrium in all restoration efforts	Basin-wide		Municipalities, VDEC, RPCs, NRCD, watershed assoc	CWIP, WG, WISPr
Buy-out properties that are highly vulnerable to flooding from willing sellers	Basin-wide		VEM, FEMA, RPCs	FEMA, HMP, PDHMP
Create & implement Emergency Action Plans for all High and Significant Hazard dams	Basin-wide		RPCs, VDEC - FED	
Decrease stormwater inputs that add to the volume of flows	Basin-wide			
FLOW ALTERATION: Restore natural flows				
Work with dam operators to mitigate flow variations and work toward run-of-river management	Connecticut River		Great River Hydro	
Work with USACE to establish ecological flows related to whitewater releases	West River		USACE	

Strategy	Priority Areas / Watershed	Town	Partners	Funding
SURFACE WATER PROTECTION: Restoration and Reclassification				
Protect through reclassification and ORW designation the waters listed in Chapter 2	Basin-wide		RPCs, NRCDs, municipalities, watershed assoc	TBPSG, 319, WG
Monitor and assess waters with no or outdated data	see Table 21		VDEC	
Evaluate waters for ORW designation	see Table 7		VDEC	
Evaluate waters for Class 1 Wetland designation	see Table 8		VDEC - Wetlands	
DIVERSITY & EQUITY: Ensure Access, Participation and Sharing of Resources				
Identify communities where water quality concerns prevent use of water or present unhealthy conditions and address these conditions	Basin-wide			
Locate implementation projects where they will offer dual advantages of open space and cleaner environment to underserved populations	Whetstone Brook, Saxtons River	Brattleboro, Bellows Falls/Westminster		
Reduce contaminants that restrict fish consumption to protect those dependent on subsistence fishing for nutrition	Connecticut River			
Identify water resource access locations that do not offer universal access and improve these conditions	Basin-wide			
Participate in VRCs "A Swimming Hole in Every Town" program to ensure no-cost recreational access to everyone	Basin-wide			
Monitor swimming waters for bacteria and cyanobacteria to ensure health and safety	Basin-wide			
Identify & protect cultural heritage / archeological sites through ORW and reclassification	Native American petroglyphs	Bellows Falls	Abenaki Tribe, CRJC, NHDES	

Strategy	Priority Areas / Watershed	Town	Partners	Funding
Implement projects to reduce flood hazards to resource-limited communities such as mobile home parks located in floodplains	Basin-wide			

D. Basin 11 Monitoring and Assessment Table

Table 21, the Monitoring and Assessment Table, provides a preliminary list of water quality monitoring priorities to guide monitoring over the next 5 years. This list has more sites than there is capacity to sample and as a result, will be further prioritized before monitoring occurs.

Table 21. Priorities for Monitoring and Assessment

Waterbody	Project Description	Location	Partners	Purpose
Lakes & Ponds				
Adam Pond	Complete shoreline assessment	Jamaica	DEC Lakes & Ponds	Insufficient Data for analysis
Ball Mountain Reservoir	Lake Assessment	Jamaica	DEC Lakes & Ponds	Insufficient Data for analysis
Burbee Pond	Lake Assessment	Windham	DEC Lakes & Ponds	Insufficient Data for analysis
Cambridgeport Pond	Complete shoreline assessment	Rockingham	DEC Lakes & Ponds	Insufficient Data for analysis
Closson Pond	Complete shoreline assessment	Rockingham	DEC Lakes & Ponds	No data
East & West Twin Ponds	Complete shoreline assessment	Athens	DEC Lakes & Ponds	No data

Waterbody	Project Description	Location	Partners	Purpose
Elwin Meadow	Complete shoreline assessment	Newfane	DEC Lakes & Ponds	No data
Forester Pond	Lake Assessment	Jamaica	DEC Lakes & Ponds	Need more data
Gale Meadows	Survey & Monitor for EWM	Londonderry	DEC L&P	Need more data
Kenny Pond	Lake Assessment	Newfane	DEC L&P	Need more data
Landgrove Pond	Complete shoreline assessment	Landgrove	DEC L&P	Insufficient Data for analysis
Lily Pond	Complete shoreline assessment	Athens	DEC L&P	Insufficient Data for analysis
Lily Pond	Lake Assessment	Londonderry	DEC L&P	Need more data
Little Pond	Lake Assessment	Winhall	DEC L&P	Insufficient Data for analysis
Lowell Lake	Lake Assessment	Londonderry	DEC L&P	Need more data
Minards Pond	Lake Assessment	Rockingham	DEC L&P	Insufficient Data for analysis
Mud Pond	Complete shoreline assessment	Peru	DEC L&P	Insufficient Data for analysis
Stratton Pond	Lake Assessment	Stratton	DEC L&P, LMP	Significantly increase nutrients levels
Stratton Ski Area	Lake Assessment	Stratton	DEC L&P	Insufficient Data for analysis
Sunset Lake	Lake Assessment	Marlboro	DEC L&P	Need more data

Waterbody	Project Description	Location	Partners	Purpose
Telephone Pond	Complete shoreline assessment	Chester	DEC L&P	Insufficient Data for analysis
Townshend Reservoir	Lake Assessment	Townshend	DEC L&P	Insufficient Data for analysis
Wantastiquet Lake	Complete shoreline assessment	Weston	DEC L&P	Need more data
Westminster-W	Complete shoreline assessment	Westminster	DEC L&P	Insufficient Data for analysis
Rivers and Streams				
Basin-wide	Biological and chemical monitoring		DEC - MAP	All listed waters to track status
WILLIAMS RIVER:				
Upper Williams River mainstem	Biological and chemical monitoring	Chester	DEC - MAP	confirm aquatic biota A(1); last monitored 2002
Middle Branch Williams River	Biological and chemical monitoring	Andover	DEC - MAP	Stressed for physical alteration
Williams River	Biological and chemical monitoring	Chester, Rockingham	DEC - MAP	Stressed for sediment, nutrients, temperature, physical alteration
Trout Brook	Biological and chemical monitoring	Andover	DEC - MAP	no data
South Branch Williams River	Biological and chemical monitoring	Chester	DEC - MAP	No data in upper watershed

Waterbody	Project Description	Location	Partners	Purpose
Hall Brook	Biological and chemical monitoring	Grafton	DEC - MAP	Potential aquatic biota reclassification; last monitored 2017
SAXTONS RIVER:				
Lower Saxtons River	Biological and chemical monitoring	Grafton-Cambridgeport	DEC - MAP	Potential aquatic biota reclassification; Excellent 2006
South Branch Saxtons	Biological and chemical monitoring	Grafton	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
Howe, Willie & Stiles Bks	Biological and chemical monitoring	Grafton, Townshend	DEC - MAP	Potential aquatic biota reclassification; local interest
Bull Creek	Biological and chemical monitoring	Athens	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
WEST RIVER:				
Stickney Brook	Biological and chemical monitoring	Dummerston	DEC - MAP	Track flows impacts
Rock River	Biological and chemical monitoring	Newfane	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
Baker Brook	Biological and chemical monitoring	Newfane	DEC - MAP	12 sq. mi. watershed with no data
Marlboro Branch (Newfane/Marlboro)	Biological and chemical monitoring	Newfane	DEC - MAP	17 sq. mi. watershed with no data
Smith Brook	Biological and chemical monitoring	Newfane	DEC - MAP	12 sq. mi. watershed with no data

Waterbody	Project Description	Location	Partners	Purpose
Grassy Brook	Biological and chemical monitoring	Brookline	DEC - MAP	14 sq. mi. watershed with no recent data
Mill Brook (Townshend)	Biological and chemical monitoring	Townshend	DEC - MAP	14 sq. mi. watershed with no data
Mill Brook & trib (Winhall)	Biological and chemical monitoring	Winhall	DEC - MAP	Altered for flow
Winhall River	Biological and chemical monitoring	Winhall, Jamaica, Londonderry	DEC - MAP	Sentinel site, Stressed for sediment & temperature
Wardsboro Brook	Biological and chemical monitoring	Jamaica	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
Waite Brook	Biological and chemical monitoring	Wardsboro	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
Dover Brook	Biological and chemical monitoring	Wardsboro	DEC - MAP	8 sq. mi. watershed with no data
Turkey Mtn Brook - upper	Biological and chemical monitoring	Jamaica	DEC - MAP	Potential aquatic biota reclassification; old data; Excellent 1987 & 1992
Utley Brook - upper	Biological and chemical monitoring	Peru	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
Griffith & Jones Brooks	Biological and chemical monitoring	Peru	DEC - MAP	No Data
Mill Brook above Gale Meadows	Biological and chemical monitoring	Winhall	DEC - MAP	No Data

Waterbody	Project Description	Location	Partners	Purpose
Mill Brook below Gale Meadows	Biological and chemical monitoring	Jamaica	DEC - MAP	Track flows impacts
Thompsonburg Brook	Biological and chemical monitoring	Londonderry	DEC - MAP	Track impact of dam removal
Rock River	Biological and chemical monitoring	Newfane	DEC - MAP	Stressed for temperature, sediment, physical alteration
Marlboro Branch	Biological and chemical monitoring	Marlboro	DEC - MAP	17 sq. mi. watershed with no data
West River above Weston	Biological and chemical monitoring	Weston	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
West River E. coli impairment	E. coli monitoring	South Londonderry	DEC - MAP	Identify sources of impairment
West River above & below Ball Mtn & Townshend dams for temperature	Temperature	Jamaica, Townshend	DFW	Track impact of dam flows and releases
West River – N of Ball Mtn Res.	Biological and chemical monitoring	Londonderry	DEC - MAP	Data gap between Ball Mtn Reservoir and Weston
West River	Brook Floater mussel	Townshend to Brattleboro	DEC - MAP	Population survey
CONNECTICUT RIVER:				
East Putney Brook - upper	Biological and chemical monitoring	Putney, Westminster	DEC - MAP	Potential aquatic biota reclassification; mixed ratings
Canoe Brook	Biological and chemical monitoring	Putney, Westminster	DEC - MAP	No Data

Waterbody	Project Description	Location	Partners	Purpose
Salmon Brook	Biological and chemical monitoring	Dummerston, Putney	DEC - MAP	Potential aquatic biota reclassification; Excellent 2017
Sacketts Brook - upper	E. coli monitoring	Putney, Westminster	DEC - MAP	Potential impairment
Crosby Brook	Biological and chemical monitoring	Dummerston, Brattleboro	DEC - MAP	Stressed for sediment
Connecticut River mainstem	flow, pH, TN	Rockingham to Brattleboro	DEC - MAP	Track impairments
Geomorphic Assessment & River Corridor Planning				
West River	SGA & RCP	Above Townshend Dam	DEC-Rivers, WCNRCD, WRC	Identify restoration opportunities
Sacketts Brook	SGA & RCP	Watershed	DEC-Rivers, WRC, WCNRCD	Identify restoration opportunities
Wetlands Assessment				
Eddy Brook complex	VRAM	Peru, Winhall		Potential reclassification
Winhall River headwaters complex	VRAM	Winhall		Potential reclassification
Putney Sand Hill Road complex	VRAM	Putney		Potential reclassification
Herricks Cove	VRAM	Rockingham		Potential reclassification
Athens Dome complex	VRAM	Athens		Potential reclassification
Volunteer Monitoring				
Athens Pond	Establish Lake Lay Monitoring & VIP Programs	Athens	VDEC – Lakes & Ponds, watershed associations	Identify, track and prevent aquatic invasive species.

Waterbody	Project Description	Location	Partners	Purpose
Burbee Pond	Establish Lake Lay Monitoring & VIP Programs	Windham	VDEC – Lakes & Ponds, watershed associations	Identify, track and prevent aquatic invasive species.
Gale Meadows	Establish Lake Lay Monitoring & VIP Programs	Londonderry	VDEC – Lakes & Ponds, watershed associations	Identify, track and prevent aquatic invasive species.
Lowell Lake	Establish Lake Lay Monitoring & VIP Programs	Londonderry	VDEC – Lakes & Ponds, watershed associations	Identify, track and prevent aquatic invasive species.
Townshend Lake	Establish Lake Lay Monitoring & VIP Programs	Townshend	VDEC – Lakes & Ponds, watershed associations	Identify, track and prevent aquatic invasive species.
Connecticut River mainstem	flow, pH, TN	Rockingham to Brattleboro	CRJC-LRS, CRC	Track impairments & discharges
Water Supply Reclassification				
Chester Reservoir	Determine current Class	Chester	DEC - MAP	Monitor to establish appropriate reclassification level
Signal Hill Brook	Determine current Class	Rockingham	DEC - MAP	Monitor to establish appropriate reclassification level
Styles Brook	Determine current Class	Stratton	DEC - MAP	Monitor to establish appropriate reclassification level
Mill Brook	Determine current Class	Westminster	DEC - MAP	Monitor to establish appropriate reclassification level

List of Acronyms References

319	Federal Clean Water Act, Section 319
604(b)	Federal Clean Water Act, Section 604b
A(1)	Class A(1) Water Classification
A(2)	Class A(2) Water Supply Classification
AAP	Accepted Agricultural Practice
ACWIP	Agricultural Clean Water Initiative Grant Program
Agency	Vermont Agency of Natural Resources
AIS	Aquatic Invasive Species
AMA	Agricultural Management Assistance Program
AMPs	Acceptable Management Practices (for logging)
ANCGIA	Aquatic Nuisance Control Grant in Aid
ANS	Aquatic Nuisance Species
AOP	Aquatic Organism Passage
AR	American Rivers
B(1)	Class B(1) Water Classification
B(2)	Class B(2) Water Classification
BASS	Biomonitoring and Aquatic Studies Section
BCCD	Bennington County Conservation District
BCRC	Bennington County Regional Commission
BMP	Best Management Practice
BR	Better Roads (VAOT)
CAP	Conservation Activity Plan
CCP	Corridor Conservation Plan
CEAP	Capital Equipment Assistance Program
CISMA	Cooperative Invasive Species Management Area
CNMP	Comprehensive Nutrient Management Plans
CRC	Connecticut River Conservancy
CREP	Conservation Reserve Enhancement Program
CRJC	Connecticut River Joint Commissions
CRP	Conservation Reserve Program
CRWFA	Connecticut River Watershed Farmers Alliance
CSP	Conservation Stewardship Program, NRCS
CWA	Federal Clean Water Act
CWI	Clean Water Initiative Grant Funding
CWIP	Clean Water Initiative Program
CWSP	Clean Water Service Provider
CWSRF	Clean Water State Revolving Fund
Department	Vermont Department of Environmental Conservation
DPW	Department of Public Works

DWSRF	Drinking Water State Revolving Fund
EBTJV	Eastern Brook Trout Joint Venture
EQIP	Environmental Quality Incentive Program, NRCS
ERP	Ecosystem Restoration Program
EU	Existing Use
FAP	Farm Agronomic Practices
FERC	Federal Energy Regulatory Commission
FSA	Farm Service Agency (USDA)
GIS	Geographic Information System
GMNF	Green Mountain National Forest
GMP	Green Mountain Power
GSI	Green Stormwater Infrastructure
IBI	Index of Biotic Integrity
IDDE	Illicit Discharge Detection (and) Elimination
LFO	Large Farm Operation
LID	Low Impact Development
Lidar	Light Detection and Ranging
LIP	Landowner Incentive Program
LIS-FF	Long Island Sound Futures Fund
LTP	Land Treatment Planner
LULC	Land Use Land Cover
LWM	Large Woody Material
MAB	Municipal Assistance Bureau
MAP	Monitoring and Assessment Program
MARC	Mount Ascutney Regional Commission
MFO	Medium Farm Operation
MPG	Municipal Planning Grant
MRGP	Municipal Roads General Permit
NHDES	New Hampshire Department of Environmental Services
NFC	Native Fish Coalition
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NMP	Nutrient Management Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPS	Non-point source pollution
NRCD	Natural Resource Conservation District
NRCS	Natural Resources Conservation Service
ORW	Outstanding Resource Water
PDM	Pre-Disaster Mitigation
PFW	Partners for Fish and Wildlife

PUC	Public Utility Commission
R,T&E	Rare, Threatened and Endangered Species
RAP	Required Agricultural Practices
RCPP	Regional Conservation Partnership Program
RMP	River Management Program
RPC	Regional Planning Commission
RRP	Rock River Preservation
SCA	Student Conservation Association
SEP	Supplemental Environmental Program
SEVT CISMA	Southeast VT Cooperative Invasive Species Management Area
SeVWA	Southeaster Vermont Watershed Alliance
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SPA	Source Protection Area
SRWC	Saxtons River Watershed Collaborative
SWG	State Wildlife Grant
SWMP	Stormwater Master Plan
TBP	Tactical Basin Plan
TBPSG	Tactical Basin Planning Support Grants
TFS/T4S	Trees for Streams
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TPL	Trust for Public Lands
TRORC	Two Rivers Ottauquechee Regional Commission
TS4	Transportation Separate Storm Sewer System General Permit
TU	Trout Unlimited
USACE	United States Army Corp of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UVA	Use Value Appraisal program, or Current Use Program
UVM Ext.	University of Vermont Extension Service
UVM	University of Vermont
VAAFM	Vermont Agency of Agriculture, Food and Markets
VABP	Vermont Agricultural Buffer Program
VACD	Vermont Association of Conservation Districts
VANR	Vermont Agency of Natural Resources
VAOT	Vermont Agency of Transportation
VDEC	Vermont Department of Environmental Conservation

VDFPR	Vermont Department of Forests, Parks and Recreation
VDFW	Vermont Department of Fish and Wildlife
VDHP	Vermont Department of Historic Preservation
VDOH	Vermont Department of Health
VEM	Vermont Emergency Management
VGS	Vermont Geological Survey
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLRP	Vermont Local Roads Program
VLT	Vermont Land Trust
VNRC	Vermont Natural Resources Council
VRC	Vermont River Conservancy
VSA	Vermont Statutes Annotated
VTrans	Vermont Agency of Transportation
VWQS	Vermont Water Quality Standards
VYCC	Vermont Youth Conservation Corp
WCNRCD	Windham County Natural Resources Conservation District
WHIP	Wildlife Habitat Incentive Program
WISPr	Water Infrastructure Sponsorship Program
WQEP	Water Quality Enhancement and Protection
WQRP	Water Quality Remediation Plan
WQS	Water Quality Standards
WRC	Windham Regional Commission
WWTF	Wastewater Treatment Facility

Appendices

Appendix A. 2015 Basin 11 TBP Status Update
Appendix B. Existing Uses
Appendix C. Dams in Basin 11
Appendix D. – West, Williams, Saxtons, Watersheds and lower Connecticut Tributaries (Basin 11) Fisheries Assessment
Appendix E. a. - ANR-USACE – Coordination Plan & Partner Agreement
Appendix E. b. ANR-USACE –Partnering Agreement
Appendix E. c. - VDFW - Assessment of the 2019 USACE whitewater release effects on aquatic resources of the West River
Appendix F. Municipal Water Quality Protectiveness Matrix
Appendix G. Regional Plan Conformance
Appendix H. Responsiveness Summary

Appendix A. 2015 Basin 11 TBP Status Update

2015 Report Card

Action	Partners	Potential Funding Sources	Implementation Location	Status
Assessment and Monitoring Projects				
Objective 1: Monitor waterbodies with no, little or old data.				
1) Monitor	VDEC – Lakes & Ponds	ANR	Adam Pond, Jamaica	Not Started (12 acres)
			Closson Pond, Rockingham	Not Started - <10 acres
			East & West Twin Ponds, Athens	Not Started - <10 acres
			Elwin Meadow, Newfane	Not Started - <10 acres
			Lily Pond, Athens	Not Started (12 acres)
	VDEC - MAPP		**WILLIAMS RIVER:**	
			Upper Williams River mainstem	2018
			Middle Branch Williams River	2017
			Trout Brook	None
			Lyman Brook	None
			South Branch Williams River	1993
			Hall Brook	2017
			SAXTONS RIVER:	

			Lower Saxtons River	2017
			South Branch Saxtons	2017
			Howe, Willie & Stiles Bks	2017, 2017, 2017
			Bull Creek	2017
			Westminster West Rd. (Barnes Brook)	2017
			Ledge Road Brook (Grafton)	Not Started
			WEST RIVER:	
			Stickney Brook	2017
			Rock River (1993)	2017
			Baker Brook	None
			Marlboro Branch (Newfane/Marlboro)	None
			Hunter Brook	2019 ???
			Smith Brook	None
			Grassy Brook	2008
			Mill Brook (Townshend)	None
			Wardsboro Brook	2017
			Dover Brook (Wardsboro)	None
			Turkey Mtn Brook - upper	1992
			Utley Brook - upper	2017
			Griffith & Jones Brooks	2005 Jones

			Mount Tabor Brook	2003
			Mill Brook above Gale Meadows	None
			Thompsonburg Brook (1990)	2017
			Simpson Brook (Townshend)	None
			West Rv above Weston	2017
			West Rv above & below Ball Mtn & Townshend dams for temperature	2017
			West River – N of Ball Mtn Res.	None
			CONNECTICUT RIVER:	
			East Putney Brook - upper	2017, 2019
			Canoe Brook	None
			Sacketts Brook - upper	2017
Objective 2: Monitor and assess the temperature issues created by the warm water in the Townshend and Ball Mountain reservoirs and the Bellows Falls and Vernon Hydroelectric dams.				
1) Monitor above and below each discharge & reservoir	USACE, EPA	USACE, ANR		In Progress-DEC; ??? - VDFW
2) Assess fisheries above and below each discharge & reservoir	USACE	USACE, ANR/VDEC & VFWD		In Progress-DEC; ??? - VDFW
Objective 3: Complete on-the-ground shoreline assessments of the lakes and ponds in the Basin.				
1) Reference WRC shoreline maps & Lake Score Cards	WRC	N/A		In Progress - nearly complete for lakes >10 acres

Objective 4: Monitor and assess to determine the location of E. coli sources in the West River in Londonderry.				
A) Conduct bracketed biomonitoring & chemical assessment	VDEC – BASS lab, SeVWA	ANR, VWG	Impaired reach	On-going / LaRosa
Objective 5: Conduct geomorphic assessment & corridor planning where these are lacking.				
1) Conduct SGA	WCNRCD, WRC	ERP, VWG	West River – Phase 2,	In Progress
			Sacketts Brook	Not Started
2) Compile corridor plan			West River, Sacketts Brook	Not Started
Objective 6: Expand volunteer monitoring on the major lakes in the Basin.				
A) Continue support for lake monitoring efforts	VDEC – Lakes & Ponds, watershed associations		Cole Pond	Not Started
B) Train and coordinate VIP monitoring program	VDEC – Lakes & Ponds, watershed associations	ANR,VWG, ANC Grant-in Aid	Connecticut River, Burbee, Gale Meadows, Lowell, Sunset, Townshend	In Progress
Objective 7: Complete aquatic organism passage assessments in the Basin.				
A) Assess all unassessed bridges and culverts	VDFW, CRWC, TU	VWG, SWG		Completed
B) Assess all dams in the VT Dam Inventory	VDFW, CRWC, TU	VWG, SWG		On-going
C) Add newly identified dams to the inventory	VDFW, VFED			On-going
Objective 8: Compile historic volunteer monitoring data on the West River for long-term trend analysis.				
A) Support SeVWA monitoring and reporting efforts	SeVWA, CRWC	VWG	West River	In Progress
Objective 9: Document vernal pools in the Basin to fully protect wetlands.				

A) Identify for protection vernal pools with the hydrology, habitat and structure to support diverse species presence in the face of climate change	Conservation commissions, watershed assoc., VCE, Arrowwood Env., NRCDs, VDFW	VWG	Full basin	In Progress
B) Identify areas to prioritize vernal pool protection and possible consideration for Class I wetland complex	Conservation commissions, watershed assoc., VCE, Arrowwood Env., NRCDs, VDFW	VWG	Full basin	Not Started
Objective 10: Obtain baseline information on distribution and abundance of mussel species. (VTWAP*)				
A) Conduct inventories of rivers and appropriate lake habitat to detect and gather information on new SGCN mussel populations	TransCanada, VDFW-NNHP, USFWS	TransCanada	Lower West River; Connecticut River – Springfield & Rockingham	In Progress
Objective 11: Conduct assessments of wetlands for potential Class I reclassification.				
A) Conduct evaluation	Watershed assoc., VDEC – Wetlands	VWG	See Table 8.	On-going
Protection Projects				
Objective 12: Work with partners to reclassify waters to the highest level of protection appropriate.				
A) Submit reclassification proposals	NRCDs, RPCs, watershed	VWG	See Tables 6-8.	On-going

	assoc., conservation			
Objective 13: Protect land and habitat along the Connecticut River to enhance survival of the high concentration of RTE species.				
A) Work with landowners to enroll land in river corridor and conservation easement	USFWS – Conte Refuge, VRC, VDFW, TNC, VLT	USFWS, PFW, CREP, CWIP	Rockingham & Brattleboro	Not Started
Objective 14: Use Corridor Plans and the WRC *Undeveloped Shorelands Maps* to prioritize and protect areas on lakes, ponds, river and streams.				
A) Set prioritization criteria and select sites	RPCs, watershed assoc., Municipalities	ANR, 604(b)	Basin-wide	On-going
B) Seek funding for purchase and easements	RPCs, Municipalities VRC	CWIP	Basin-wide	On-going
Objective 15: Protect and restore habitats on which SGCN mussels are dependent through pollution abatement, riparian buffers, flow regulation, etc. (VTWAP)				
A) Acquire conservation easements for the protection of critical SGCN mussel habitats and maintenance or restoration of ecological functions			Lower West River; Connecticut River – Springfield & Rockingham	Not Started
B) Investigate the potential benefits of dam removal to SGCN mussel populations			Blake & Higgins(Westminster), Sacketts (Putney)	On-going
Restoration Projects - Basin-wide				
Objective 16: Restore streambanks and floodplains in the Basin.				

A) Work with landowners to install buffers and protect shoreline and/or riparian areas through a combination of buffer plantings, land conservation, and incentive programs	NRCDs, NRCS, AAFM	T4S, CREP, AAFM, CWIP, LIS-RCPP		On-going
Objective 17: Remove dams that are no longer serving a useful purpose.				
A) Sacketts Brook Dam, Putney	VDFW, VT Dam Task Force, USFWS	AR/NOAA, CWIP, USFWS-EBTJV		Not Started
B) Williams Dam, Londonderry	VDFW, VT Dam Task Force, USFWS	AR/NOAA, CWIP, USFWS-EBTJV		Under Discussion
C) Prioritize dams using the revised TNC analysis and an assessment of removal potential and initiate additional removal projects	VDFW, VT Dam Task Force, USFWS	AR/NOAA, CWIP, USFWS-EBTJV		On-going
D) Conduct training for staff and partners on dam removal and wetland restoration	VDEC-MAPP, USFWS, NRCS, VDEC - Wetlands	CWIP, PFW, WRP/DU, USFWS, VWG		In Progress
E) Restore the functions of any remaining wetland	WRP/DU	AR/NOAA, CWIP		On-going
Objective 18: Ensure that all in-service dams have an Emergency Action Plan in place and up-to-date.				
A) Work with towns on creating or updating EAPs.	RPCs, Municipalities	604(b)	Priority: Wantastiquet Lake, Mahoney Pond	Under Discussion
Objective 19: Implement buffer restoration and planting projects in priority areas.				
A) Conduct landowner outreach and recruitment for buffer projects.	NRCDs	AAFM, CWIP, LIS RCPP	**WEST RIVER**: 43.301105, -72.787006 - Weston	

			43.261901, -72.794620 - Weston	
			43.253064, -72.793215 - Weston	
			43.247106, -72.788805 - Londonderry	
			43.200300, -72.822687 - Londonderry	
			42.999219, -72.637658 - Townshend	
			42.981301, -72.636954 - Newfane	
			42.868542, -72.567420 – Brattleboro	
			SAXTONS RIVER:	
			43.123345, -72.463825 – Westminster	
			43.133100, -72.481923 – Westminster	
			43.164363, -72.612902 – Grafton	
			WILLIAMS RIVER:	

			43.207496, -72.536080 – Chester	
			43.246833, -72.570472 – Chester	
			43.267267, -72.585537 – Chester	
			43.272660, -72.592999 – Chester	
			43.284867, -72.604688 - – Chester	
			43.300253, -72.606369 – Chester	
			43.244150, -72.619132 – Chester	
			CONNECTICUT RIVER:	
			42.900490, -72.531629 – Dummerston	
			42.983261, -72.462444 – Putney	
			43.006507, -72.444503 – Putney	

			43.076001, -72.440890 – Westminster	
			43.234699, -72.436444 – Springfield	
B) Work with willing landowners to install buffers.	NRCDs	AAFM, CWIP, LIS RCPP		On-going
C) Work with towns to restore buffers on all FEMA Buy-out properties	NRCDs	AAFM, CWIP, LIS RCPP		Completed / On-going
Objective 20: Restore degraded wetlands.				
A) Repair damage from mass failure collapse into wetland.	NRCS, NRCDs	CWIP, USDA, LIS-RCPP	Rockingham @ 43.20429, -72.50675	Not Started
B) Prioritize and restore wetlands recommended by Wetlands staff	VDEC - Wetlands	CWIP, LIS-RCPP	See Table 8.	On-going
C) Provide assistance with installation of flow devices to protect wetlands and roads	VDFW	VDFW, USFWS	Basin-wide	On-going
Objective 21: Encourage and implement green infrastructure practices to reduce stormwater runoff.				
A) Work with municipalities to incorporate local regulatory approaches to encourage GSI and LID	RPCs, NRCDs, VDEC, watershed assoc.	CWIP, VAPDA	Bellows Falls, Brattleboro, Londonderry, Stratton, Winhall	On-going
Objective 22: Promote littoral habitat protection on lakes by control of shoreland erosion, nutrient loss and sedimentation.				
A) Promote and initiate the Lake Wise program	VDEC – Lakes & Ponds, Lake Assoc.		Burbee Pond, Sunset Lake	On-going

B) Conduct invasive species evaluation and protection programs on the lakes	VDEC – Lakes & Ponds, Lake Assoc.		Burbee Pond, Gale Meadows, Lowell Lake, Sunset Lake, Townshend Reservoir	On-going
C) Establish a control program to reduce the levels of Eurasian watermilfoil	Lake Assoc.	ANS Grant-in Aid	Gale Meadows Lake	On-going
D) Build local knowledge of shoreland BMPs among contractors, landscapers and other shoreland site workers by offering the Shoreline Erosion Control Certification Course annually	VDEC – Lakes & Ponds, Lake Assoc.	VWG, CWIP	Basin-wide	On-going
E) Recruit homeowners, recreation area managers and state parks to develop demonstration sites showcasing shoreland best management practices	VDEC – Lakes & Ponds, Lake Assoc.	VWG, CWIP	Basin-wide	On-going
Objective 23: Prevent the further spread of Japanese knotweed in the Basin.				
A) Conduct outreach on control and spread prevention	NRCDs, watershed assoc., RPCs	ANS Grant-in Aid, WG,	Basin-wide	On-going
B) Organize pulling events and outreach.	Conservation Commissions, NRCDs	ANS Grant-in Aid, WG	Focus area: Saxtons River	On-going
Objective 24: Dovetail continued post-closure monitoring programs of landfills with working on fixes for known water quality impacts following the end of the required monitoring in 2013.				
A) Maintain water monitoring programs	VDEC - WMD	SWAG - CPP	Municipal landfills in Athens, Brattleboro, Dummerston, Grafton, Jamaica, Londonderry, Newfane, Putney, Rockingham,	Not Started

			Townshend, Wardsboro, Winhall	
B) Develop and implement clean-up projects at impacted locations	VDEC - WMD	SWAG - CPP		Not Started
Objective 25: Reduce sand and sediment inputs from gravel roads throughout the Basin.				
A) Provide more training and education for road agents on preventing erosion	VTrans-Local Roads, Municipal DPW's, RPCs, NRCDs	Local Roads	Basin-wide	On-going
B) Conduct BBR capital budget and road erosion inventories for AOP impediments, and river-road conflicts with an emphasis on flood resiliency	Municipal DPWs, VTrans-Better Backroads technician, RPCs, VDEC	BBR, CWIP	Andover, Athens, Brattleboro, Brookline, Chester, Dover, Grafton, Jamaica, Mount Tabor, Newfane, Peru, Putney, Rockingham, Springfield, Stratton, Townshend, Wardsboro, Westminster, Weston, Windham	In Progress
C) Seek funding for regionally shared equipment for sand sweeping, catch basin sump cleaning and reduced use of sand & salt with possible conversion to brine	Municipal DPWs, VTrans-Better Backroads	BBR, 319, VTrans	Brattleboro, Dover, Chester, Londonderry, Rockingham Stratton,	On-going

	technician, VDEC		Westminster, Winhall	
D) Conduct an assessment of water quality impairments associated with Class IV town roads using the model developed for the Basin	VDEC, Municipalities, RPCs, VDFPR, VTrans-Better Backroads, watershed assoc.	CWIP, BBR	Selected sites with High to Moderate Risk for Road Erosion	In Progress
E) Reduce the amount of sediment and other pollutants associated with Class IV town roads	Municipal DPWs, RPCs, VTrans-Better Backroads, VDEC, VDFPR, VYCC	CWIP, DREF, VYCC, Hazard Mitigation Grant Program	Selected sites based on D)	On-going
Objective 26: Improve fisheries and fish habitat throughout the Basin.				
A) Conduct AOP Stream Crossing assessments on unassessed waters	VDFW, TU, CRWC, watershed assoc.	VDFW	Williams River watershed, CT River tributaries	Completed / On-going
B) Develop project implementation plan where above assessments indicate	VDFW, NRCDs, TU, CRWC, watershed assoc.	VWG, CWIP, AOP		On-going
C) Implement habitat improvement projects	VDFW, NRCDs, TU, CRWC,	WG, CWIP, EBTJV, USFWS-AOP	Focus areas: lower West River, Rock River, CT River tribs	On-going

	watershed assoc.	, Structures, USFS, PFW		
D) Protect and restore forested riparian lands adjacent to all streams for WQ, temperature, riparian and instream habitat improvement	VDFW, NRCDs, TU, CRWC, watershed assoc.	VWG, CWIP, USFS, PFW, LIS-RCPP	Focus areas: Lower Saxtons and lower Williams, upper West	On-going
Objective 27: Reduce non-point source pollutants from farming operations by implementing BMPs on farms.				
A) Conduct farm assessments and outreach visits to livestock farms in focus areas	NRCDs, AAFM, VACD	AAFM, WG, NRCS, LIS-RCPP	West River: Weston, Townshend, Newfane	In Progress
			Williams River:	In Progress
			Mainstem in Chester/ Rockingham &	In Progress
			Middle Branch-Chester	In Progress
			Saxtons River:	In Progress
			South Branch & Bull Creek	In Progress
			CTR watershed:	In Progress
			CTR mainstem in Putney, Rockingham, Westminster; Sacketts Brook – Westminster Rd trib.	In Progress
B) Coordinate referrals of potential program staff	NRCDs, VACD, AAFM,	NRCS, LIS-RCPP		On-going

	NRCS, CRWC			
C) Develop critical source areas for nitrogen and sediment	AAFM, NRCS	NRCS, LIS-RCPP		Not Started
D) Implement BMP's on prioritized critical source areas	NRCDs, VACD, AAFM, NRCS	EQIP, CREP, AAFM, PFW, WRP/DU, 319, LIS-RCPP		On-going
Forestry				
Objective 28: Reduce non-point source pollution associated with logging operations by implementing AMPs and by promoting the use of portable skidder bridges.				
A) Continue the AMP Monitoring Program administered by DFPR	VDFPR, DEC Compliance and Enforcement Division, Vermont Forest Products Association	State General Funds	Basin-wide	On-going
B) Support the Portable Skidder Bridge Rental Program	NRCDs, VDFPR	CWIP	Basin-wide	On-going
C) Promote Voluntary Harvesting Guidelines	VDFRP, NRCDs	VWG, USFS	Basin-wide	On-going
Objective 29: Improve planning and management of the urban trees to improve stormwater retention.				
A) Promote the planning and management of urban trees for stormwater mitigation to municipalities	NRCDs, RPCs, VDFPR , UVM Extension	VDFPR , USFS	Urban areas Focus: Bellows Falls, Brattleboro, ski resorts, No. Westminster	On-going
B) Inventory and assess urban trees for new & retrofit installation of stormwater mitigation strategies	Municipal Con. Comm.	VDFPR , USFS	All municipalities	Not Started

	& Tree wardens			
C) Promote the benefits of trees and forests for water quality	VDFPR , UVM Extension, all natural resource partners	VDFPR , USFS	Basin-wide	On-going
D) Encourage participation in the Stewardship of the Urban Landscape - Tree Stewards course	VDFPR , UVM Extension	VDFPR , USFS	Basin-wide	Not Started
Objective 30: Encourage and support smart growth development and compact village centers and downtowns to slow forest fragmentation.				
A) Promote ACCD Community Revitilization programs	VDFPR, VDEC, RPCs	VDEC	Basin-wide, focus areas: resort development, Brattleboro, Stratton, Wardsboro, Winhall	On-going
B) Identify high-priority landscapes for conservation efforts	VDFPR, VDEC			On-going
Flood Resiliency				
Objective 31: Incorporate river corridors, floodplain protection and flood resiliency strategies into local and regional development plans and zoning.				
A) Focus on areas of highest risk identified in River Corridor plans	RPC's, Town Planning and Conservation Commissions, VLCT	MPG, 604(b)	Focus Towns: Brattleboro, Chester, Grafton, Jamaica, Newfane, Saxtons River	On-going
B) Prevent further encroachment into floodplains and wetlands	Municipalities		Williams River and Middle Branch	On-going

Objective 32: Update municipal plans and programs to incorporate ERAF standards.				
A1) Focus on towns at highest risk identified in River Corridor plans	RPC's, Town Planning and Conservation Commissions, VLCT	MPG	Focus Towns: Chester, Londonderry, Jamaica, Newfane, Brattleboro	On-going
Objective 33: Reconnect agricultural land on floodplains for flood storage.				
A) Identify lands disconnected from flooding access and landowners willing to re-establish natural hydrology	NRCS, NRCDs,	HMGP, LIS-RCPP		On-going
B) Restore wetlands that have been previously converted to agriculture for flood storage	NRCS, NRCDs,	HMGP, LIS-RCPP	Chester, Putney, Rockingham, Westminster, Weston	Not Started
C) Investigate creating a local and/or state-wide crop damage reimbursement program for farmers willing to allow reconnection of fields for floodplain access	NRCS, VT Legislature, Town select board	USDA, VT Legislature		Not Started
Objective 34: Implement stormwater control projects and green infrastructure practices to reduce flows and sediment wherever possible.				
A) Conduct stormwater surveys, IDDE investigations and develop stormwater master plans	VDEC - Stormwater	CWIP	Focus area priority: Bellows Falls, Chester, and No. Westminster villages Stratton/Winhall resort areas.	On-going
B) Prioritize and implement stormwater control projects	VDEC, Municipalities, Ski Resorts	CWIP, private	As determined by A)	On-going
C) Promote local regulatory and incentive approaches to encourage GSI and LID	VDEC	CWIP, VAPDA	Basin-wide	On-going

Objective 35: Monitor and document impacts of TS Irene and other flood events.				
A) Document erosion damage & mass failures	VGS, RPCS, BCRC, SGA Consultants	604(b)	Basin-wide	Completed
B) Document repeated infrastructure problems and concerns	RPCS, BCRC, VTrans, SGA Consultants	604(b)	Basin-wide	Completed
C) Develop remediation projects where appropriate	RPCS, BCRC, SGA Consultants	604(b), BBR	Basin-wide	On-going
D) Update delineated SGA and FEH corridors where river has migrated outside of boundary	VDEC – Rivers Program	ANR	Where applicable	On-going
West River				
Objective 36: Work with USACE to address river impacts related to temperature and flow alterations below the flood control dams as listed in Part F.				
A) Develop & implement mitigation strategies	VDEC, USFS, TransCanada	TransCanada	Below dams	On-going
B) Develop & implement mitigation strategies	VDEC, TransCanada, USFS	TransCanada	Below the Somerset Reservoir(from fisheries)	Not Started
Objective 37: Support SeVWA and other local watershed groups in their water quality monitoring work.				
A) Assist with program development and implementation	VDEC-MAPP			On-going
B) Assist with funding	VDEC-MAPP	VWG, CWIP		On-going
Objective 38: Correct water quality impairments due to flow alterations to Mill Brook and tributary by Bromley Mountain snowmaking withdrawal.				
A) Complete an Needs and Alternative Analysis to determine an alternative for snowmaking	Bromley Mountain Resort	Private	Mill Brook and tributary	Not Started

B) Work with resort to implement projects	Bromley Mountain Resort, Act250, VDEC	Private		Not Started
Objective 39: Work with the towns of Winhall, Londonderry, Jamaica and Wardsboro to address sediment and temperature impairments on the Winhall River and Wardsboro Brook.				
A) Conduct road erosion and buffer assessments	WCNRCD, WRC	CWIP	Cohen Rd, Goodaleville Rd, Kendall Farm Rd, River Rd, Raspberry Hill Rd, Winhall Hollow Rd, French Hollow Rd	In Progress
B) Prioritize these sites & develop implementation projects	WCNRCD, WRC, VDEC	CWIP		In Progress
C) Implement projects	WCNRCD, WRC, VDEC	CWIP		In Progress
Objective 40: Implement recommendations of the West River Bacteria TMDL to control high levels of bacteria in Londonderry.				
A) Pursue and address failing or malfunctioning onsite septic systems	Town DPW, SeVWA, property owners	WG, CWIP, CWSRF	Londonderry village to below South Londonderry village	In Progress
B) Pursue and address stormwater runoff from developed areas	Town DPW, SeVWA, property owners	CWIP, WG		On-going
C) Pursue and address illicit discharges	Town DPW	Town DPW		In Progress
D) Expand citizen education about the negative impacts of stormwater, with a focus on the importance of picking up after one's pet.	SeVWA, WCNRCD	WG		On-going

E) Support programs that assist with the replacement or upgrading of failed onsite septic systems or expansion of the municipal wastewater system to reach more residences.	Town DPW	CWSRF		On-going
Objective 41: Coordinate with Federal and State agencies to address flow impairment of Flood Brook due to Hapgood Pond impoundment and annual drawdown.				
A) Coordinate meetings to develop management strategies	VDEC, VDFW, USFS		Hapgood Pond	Not Started
Williams River				
Objective 42: Work with the towns of Chester and Rockingham to address sediment, nutrient and temperature impairments on the lower river.				
A) Conduct road erosion assessments	DPWS, NRCDs, RPCs	BBR, VWG	Both Pleasant Valley Rds, Popple Dungeon Rd, Parker Hill	In Progress
B) Conduct resource concern and farm assessments of ag operations	NRCDs	AAFM, CWIP, LIS-RCPP		In Progress
C) Develop implementation projects	NRCDs, RPCs	AAFM, NRCS, LIS-RCPP		Not Started
D) Seek funding	NRCDs, RPCs	AAFM, NRCS, BBR, LIS-RCPP		On-going
E) Implement projects	NRCDs, RPCs	AAFM, NRCS, BBR, LIS-RCPP		On-going
Objective 43: Work with the town of Chester to increase flood resiliency.				
A) Identify flood damage-prone infrastructure and flood prone properties for evaluation of resiliency	Town, VDEC, SWCRPC		Middle Branch	Completed
B) Work with FEMA Buy-out program	Town, SWCRPC	FEMA	Town-wide	Completed

C) Work with town on zoning regulations for river corridor protection	VDEC			On-going
D) Promote ERAF and NFIP programs	VDEC, SWCRPC			On-going
E) Reduce stormwater inputs with GSI and LID	Town, VDEC, SWCRPC		Chester village & Depot	On-going
Objective 44: Preserve existing and restore impacted floodplains in the Williams River watershed.				
A) Seek RCE opportunities	VRC	CWIP, LIS-RCPP	South Branch & Middle Branch	In Progress
B) Seek floodplain reconnection and restoration opportunities	NRCDs, RPCs	CWIP, LIS-RCPP	Along Rte 103 S, Chester & Rockingham e.g. @ 43.23766 -72.55286; 43.29740 -72.60841	On-going
C) Preserve agricultural fields serving as flood storage	NRCS	CWIP, EQIP, LIS-RCPP	Swett Rd, Rte 103N, Green Mtn Turnpike, Williams Rd	Not Started
D) Remove berms constructed in 1970's and post-TSI	NRCD, Municipalities	CWIP	Williams River, Middle Branch e.g. @ 43.269062, -72.621415; 43.262421, -72.598895	Not Started
E) Work with willing landowners on flood proofing or buyouts		HMGP, CWIP	43.343536, -72.621205	On-going
Saxtons River				
Objective 45: Work with the towns of Grafton and Rockingham to address sediment, nutrient and temperature impairments on the lower river.				

A) Conduct resource concern and farm assessments of ag operations	WCNRCD , AAFM	VWG, CWIP, LIS-RCPP	Downstream of Hall Bridge Rd; Bull Creek; South Branch	In Progress
B) Develop implementation projects	WCNRCD , AAFM	BBR, VWG, CWIP, LIS-RCPP		Not Started
C) Seek funding	WCNRCD , AAFM	BBR, VWG, CWIP, LIS-RCPP		On-going
D) Implement projects	WCNRCD , AAFM	BBR, VWG, CWIP, LIS-RCPP		Not Started
Objective 46: Implement priority projects identified in the Saxtons River Corridor Plan.				
A) Basin Farm corridor protection and buffer planting	WCNRCD, VRC, NRCS	CWIP, EQIP, LIS-RCPP	M02 - 43.12145, -72.44610	Under Discussion
B) Berm removal and corridor protection on mainstem above SR village	VRC, WCNRCD, NRCS	CWIP, EQIP	M07 - 43.13598,-72.51519	Not Started
C) Dam removal and corridor protection at confluence with South Branch	Windham Foundation, WCNRCD	CWIP, AR/NOAA, EBTJV, GMNF, AOP	T6.01 - 43.168468, -72.607066	Completed dam removal
D) Corridor Protection upstream of Grafton Village	VRC	CWIP	M15 and above	Not Started
E) Stormwater Mgt. at Alpaca Farm north of Grafton Village	NRCS	EQIP, LIS-RCPP	M15 - 43.18783, -72.61782	Not Started
F) Culvert replacement on Mercy Lane	DPW, WCNRCD	Structures, AOP	M20 - 43.19901, -72.69727	Not Started
G) Buffer Planting upstream of Mercy Lane	WCNRCD	CWIP, VWG	M20 - 43.19902, -72.69812	Not Started
H) Bull Creek - CREP Buffer Easement and Planting east of Route 35	NRCS, WCNRCD, VRC	CREP, CWIP, LIS-RCPP	T4.01 - 43.14110, -72.56025	Completed

I) Willie Brook & Styles Brook -	WCNRCD, VRC	CWIP, LIS-RCPP	T6.S2.01 -- 43.141975, -72.629411; T6.S2.01 -- 43.13172, -72.63880;	Under Discussion
· Protect Corridor west of Townshend Road in Grafton			T6.04 -- 43.12670, -72.64075	Under Discussion
· Protect alluvial fans				Under Discussion
J) Remove berms built post-Irene	WCNRCD, Town DPW	CWIP	Most brooks and South Branch, Willie Brook at 43.13099, -72.63734 and Stiles Brook at 43.12693, -72.63921	Not Started
Ball Mountain Brook				
Objective 47: Implement recommendations of the Corridor Plan.				
A) Protect corridor; monitor head cut; remove berms	VDEC, WCNRCD	CWIP	T0805	Not Started
B) Dalewood Rd. reduce sediment inputs; explore history & consider restoration to old channel beds	WCNRCD, DPW	BBR, CWIP	T08.04-S1.04-S1.01	Not Started
E) Protect corridor; remove berms and consider removing old abutments	WCNRCD, VRC	CWIP	T08.04-S1.01B	Not Started
F) Styles Brook remove berm and replace structure	WCNRCD, Municipal DPW	CWIP, Structures	T08.04-S1.10-S1.01	Not Started
Objective 48: Continue working with Stratton Mountain Resort to implement the Water Quality Remediation Plan for sediment to address water quality impairments in the Brook and tributaries.				
A) Conduct annual update meetings, planning and monitoring work	Stratton Resort,	Private	Stratton Mountain Resort	On-going

	Act250, VDEC			
B) Work with resort to implement projects	Stratton Resort, Act250, VDEC	Private	As determined by WQRP	On-going
Rock River				
Objective 49: Implement recommendations of Corridor Plan.				
A) Protect corridor; possible restoration of channel to old bed	VDEC, WCNRCD, VRC	CWIP	T02.04	Not Started
B) Protect corridor	WCNRCD, VRC	CWIP	T02.05A;	Not Started
C) Protect corridor; manage invasives	WCNRCD, VRC	CWIP	T02.05-S1.01	Not Started
D) Corridor Conservation & limited berm removal	WCNRCD, VRC	CWIP	T02.05-S1.02	Not Started Not Started
E) Replace 5 structures	WCNRCD, Municipal DPW	CWIP, Structures	T02.11-S1.01A	Not Started
F) Protect corridor; buffer establishment at horse farm	WCNRCD	VWG, CWIP, LIS-RCPP	T02.11-S1.01B	Not Started
Objective 50: Remove streambed armoring from Adams Brook to repair damage to aquatic habitat, cut sedimentation and remove impoundment.				
A) Remove material and restore streambed and banks	VDFW, WRC, WCNRCD	VWG, CWIP	42.95015, -72.75777	Completed
Winhall River				
Objective 51: Implement recommendations of Corridor Plan.				
A) Protect corridor and restore riparian buffer	VDEC, WCNRCD, VRC	CWIP, VWG, CREP	T11.04	Completed

B) Move River Road embankment back to reduce encroachment	VDEC, WCNRCD, WRC	CWIP, VWG	T11.05-A	Not Started
C) Remove windrowed berm and increase floodplain access	VDEC, WCNRCD, WRC	CWIP, VWG	T11.06-A	Not Started
D) Protect corridor	VDEC, VRC, VLT	CWIP, VWG	T11.08-A & B	Not Started
Wardsboro Brook				
Objective 52: Implement recommendations of Corridor Plan.				
A) Protect corridor and alluvial fan	VDEC, WRC, VRC , WCNRCD	CWIP, VWG, CREP	T8.01-A & B	Not Started
B) i. Assess potential impact of berm removals	VDEC, VTrans, WRC, WCNRCD	CWIP, VWG	T8.01 & .02	Not Started
ii. Remove berms and increase floodplain access				Not Started
C) Restore Riparian Buffer	VDEC, WCNRCD	CWIP, VWG, TFS	T8.03	Not Started
D) Protect corridor, restore floodplain	VDEC, WRC, VRC	CWIP, VWG	T8.03, .04 & .05	Not Started
E) Arrest headcuts	WCNRDC, WRC	CWIP	T8.01-D, T8.02, T8.03, T8.04, T8.06A	Not Started
F) Replace box culvert under Rt. 100 and Cross Rd	VTrans		T8.S3.01	Not Started
Connecticut River				
Objective 53: Implement recommendations of the LIS-TMDL to reduce point source nitrogen (N) loads by 25%.				
A) Identify sources and implement reduction practices	Municipal WWTFs, industrial N dischargers	CWSRF, LIS-RCPP		On-going
Objective 54: Implement recommendations of the LIS-TMDL to reduce non-point source nitrogen loads by 10%.				

A) Educate ag producers on N reduction practices	AAFM, NRCS, NRCDs, ag producers	LIS-RCPP	Basin-wide	On-going
B) Implement appropriate practices including:	AAFM, NRCS, NRCDs, ag producers	EQIP, AAFM, VACD, CREP, LIS-RCPP	Basin-wide	On-going
· Increased soil testing				
· Nutrient Management Planning				
· Timed fertilizer application				
· Needs based N application rates				
· Use of cover crops & perennial grasses				
· Extended rotation periods				
· Install wood chip filter beds/trenches to treat drainage water				
· Increase riparian buffers				
Objective 55: Implement projects from the Brattleboro Stormwater Mapping Project,*and the Putney Road Stormwater Study.† **SEE CROSBY BROOK**				
A) Assess potential for an extended stormwater detention pond	VDEC-Stormwater, Town of Brattleboro	CWIP, CWSRF	Drainage Area #68 - Off Cedar St. at 42.858552, -72.569073	Not Started
B) Assess potential for extended stormwater detention pond	VDEC-Stormwater, Town of Brattleboro	CWIP, CWSRF	Drainage Area #152 - Behind Royal Shopping Plaza at 42.873814, -72.563598	Not Started
C) Reroute stormwater from Rte 9 to enlarged swirl separator and sand filter to CT River	VTrans, VDEC-Stormwater, VTrans, Town of Brattleboro	CWIP, AOT, CWSRF	Drainage area #173* - Before Rte 9 bridge to NH at 42.883878, -72.552804	Not Started

D) Assess potential for extended stormwater detention pond	VDEC-Stormwater, Town of Brattleboro	CWIP, CWSRF	Drainage area #177* - End of Glen Orne Dr. at 42.890898, -72.543095	Not Started
E) Construct 2 stormwater detention ponds in series	VDEC-Stormwater, WCNRCD, landowner	CWIP, CWSRF	Site 1.1† - private property south of Hardwood Way at 42.880367, -72.556635	Not Started
F) Construct stormwater detention ponds – wet ponds and gravel ponds	VDEC-Stormwater, WCNRCD, landowner	CWIP, CWSRF	Site 1.4† - private property along Rte 9 to NH at 42.884009, -72.555107	Not Started
G) Retrofit swales for pre-treatment, infiltration and storage	VTrans, VDEC-Stormwater, WCNRCD, landowner	CWIP, CWSRF	Site 2.2† - I-91 ROW at Black Mtn Rd. at 42.882846, -72.562209	Not Started
H) Retrofit swales for pre-treatment, infiltration and storage	VTrans, VDEC-Stormwater, WCNRCD, landowner	CWIP, CWSRF	Site 2.4† - I-91 ROW at Exit 3 - at 42.888234, -72.557671	Not Started
I) Upgrade and extended stormwater detention pond	VTrans, VDEC-Stormwater, WCNRCD, landowner	CWIP, CWSRF	Site 1.10† - C&S property at 42.892923, -72.550968	Under Discussion
Objective 56: Work with the TransCanada, through the FERC relicensing process, to address river impairments related to flow issues on the Connecticut River listed in Part F -Waters Altered by Flow Regulation.				

A) Above and below the Vernon Dam	TransCanada, FERC, USFWS, NHFG, TNC, CRWC, others	TransCanada	CT River, above and below the Vernon Dam	In Progress
B) Below the Bellows Falls Dam	Same	TransCanada	CT River, below the Bellows Falls Dam	In Progress
Objective 57: Work with the TransCanada to improve riparian buffers along the river on TC held lands.				
A) Monitor ag lands for buffer compliance	TransCanada	TransCanada		Not Started
B) Incorporate buffer requirements into ag land leases	Same	TransCanada		Completed
Objective 58: Preserve existing and create more floodplain along the Connecticut River.				
A) Assess current floodplain quantity & capacity	TNC	WG		Not Started
B) Seek and purchase RCE opportunities	VRC, CRWC, CRJC	CWIP, LIS-RCPP		On-going
C) Seek floodplain reconnection and restoration opportunities	TNC, CRWC, CRJC	CWIP, LIS-RCPP		On-going
Objective 59: Work with regulators and dam operators/owners to reduce the impacts of dam operations on SGCN mussel populations. (VTWAP)				
A) Identify sources and implement reduction practices	Municipal WWTFs, industrial N dischargers, TNC	CWSRF	See Section 3.7	In Progress
Commissary Brook				
Objective 60: Reduce sediment inputs to the Connecticut River from mass failures and erosion on first tributary.				
A) Assess geomorphic conditions	CRJC, RCC, landowner	CWIP		Not Started
1) Work with Town and landowner to develop implementation plan		VWG, CWIP		Not Started

B) Implement plan strategies		CWIP		Not Started
East Putney Brook				
Objective 61: Investigate replacing or retrofitting the perched culvert at the River Rd. crossing.				
A) Work with NEC RR to assess culvert and develop plan	NEC RR, USFWS		42.985724, -72.468608	On-going
B) Seek funding for implementation	VTrans	Structures, USFWS-EBTJV		On-going
Objective 62: Conduct outreach and promote riparian buffers on agricultural and open lands in the watershed.				
A) Conduct outreach and assessments with landowners for buffer compliance with RAPs	WCNRCD, NRCS, CRWC, TU, watershed. Assoc.	AAFM, CREP, VWG, CWIP, LIS-RCPP	e.g.: 43.060461, -72.538313; 43.052700, -72.535406; 43.040210, -72.528446; 43.046200, -72.523092; 43.039100, -72.525149; 43.021123, -72.500464; 43.020178, -72.498007; 43.002523, -72.476460; 42.996662, -72.477093; 42.985605, -72.467162	On-going
B) Work with landowners to install buffers	WCNRCD, CRWC	AAFM, CREP, VWG, CWIP, LIS-RCPP		On-going

Ellis Brook, Farr Brook				
Objective 63: Develop a plan for addressing the insufficient flows in the lower brook caused by the Bellows Falls Water Dept. water withdrawal.				
A) Coordinate with BFWD on plan development	VDWGPD, Bellows Falls Water Dept., VDEC			Not Started
B) Implement plan strategies	Bellows Falls Water Dept.	CWSRF		Not Started
Sacketts Brook				
Objective 64: Develop a plan for addressing the insufficient flows in the lower brook caused by the paper mill water withdrawal.				
A) Coordinate with paper mill on plan development	VDEC, permittee	private	Impaired reach	Not Started
B) Implement plan strategies				Not Started
Objective 65: Sand Hill Road / Wilson wetlands management				
A) Assess wetlands to determine ways to re-establish natural hydrology post -TSI	VDEC – Wetlands & Rivers, VDFW	VWG	Sand Hill Road	Completed
B) Coordinate with Putney Con. Comm. on wetland management plan and beaver management	VDEC – WSMD, VDFW, WRC			On-going
C) Work with DPW on road erosion and stability issues	VDEC, DPW, PCC	BBR, Structures, HMGP		On-going
Crosby Brook *				
Objective XX: Reduce sediment impacts to Crosby Brook.				
1) Enlarge the capacity of the C&S stormwater pond	C&S, VDEC-Stormwater	private	42.892878, -72.550964	Under Discussion
2) Address the mass failure on Black Mountain Rd.	WCNRCD, VDEC-Rivers	ERP	42.885587, -72.565995	Not Started

3) Address erosion on Black Mountain Rd.	Town of Brattleboro	BBR		Completed / Under Discussion
4) Implement priority projects from the Corridor Plan	WCNRCD, WRC, Towns of Brattleboro & Dummerston	ERP, WG		On-going
5) Implement priority projects from Putney Road Restoration Study	AOT, Town of Brattleboro	Enhancement, ERP, WG, Windham Fdn	Ryan Road to Landmark Hill Driver	On-going
6) Address erosion on gravel roads	Towns of Brattleboro & Dummerston	BBR, ERP		On-going
Objective XX: Replace or retrofit structures prioritized in the Crosby Brook Corridor Plan.				
1) Ryan Road	Town of Dummerston	BBR, ERP	42.899759, -72.551597	Not Started
2) Middle Road (upper)	Town of Dummerston	BBR, ERP		Not Started
3) Black Mountain Road	Town of Brattleboro	BBR, ERP	42.88317, -72.563421	Not Started
4) Dickinson Road	Town of Brattleboro	BBR, ERP	42.888716, -72.569686	Not Started
Objective XX: Encourage Low Impact Development (LID) by offering development density incentives for those projects which result in reduced footprints of impervious cover.				
Implement zoning bylaws allowing greater residential densities with the implementation of LID techniques.	RPCs, Towns,	604(b)		On-going

	WSMD – Stormwater, VLCT			

** Crosby Brook was Planned with Basin 12 in 2014 but is now in Basin 11*

Appendix B. Existing Uses

Swimming / Contact Recreation

Much of the swimming in the basin takes places on the many lakes and ponds which have presumed existing use of contact recreation.

Waterbody	Site	Location of Use	Town	Documentation of Existing Use
West River Watershed				
West River	Greendale Brook confluence off Lawrence Hill Rd	Across from Weston Rec Club	Weston	1989 Upper West River Basin Water Quality Management Plan (S-WW2)
	South Londonderry	USACE lands	South Londonderry	Swimming hole below bridge
	Jamaica State Park	Swimming beach and along entire reach	Jamaica	1989 Upper West River Basin Water Quality Management Plan (S-J8)
	Ball Mountain Reservoir	USACE lands	Jamaica	1989 Upper West River Basin Water Quality Management Plan (S-J5)
	Gilfeather Rd bridge	Private	Jamaica	1989 Upper West River Basin Water Quality Management Plan (S-J9)
	Scott Covered Bridge	USACE lands	Townshend	Swimming hole below bridge
	Brookline Bridge	West River crossing Newfane/Brookline town line	Brookline / Newfane	Swimming hole below bridge
	Dummerston Covered Bridge	Rte. 30 jct. of Eastwest Rd.	Dummerston	Swimming hole below bridge
	Deyo's Hole	Rte. 30	Dummerston	Swimming hole off Rte. 30 ROW
	West River Park	Rte. 30, town rec area	Brattleboro	Swimming hole in town park
Winhall River	Winhall Campground - Winhall & West confluence	USACE lands	Winhall	Swimming beach at USACE campground
Winhall River	West of Rt 100 bridge	Private	Jamaica	1989 Upper West River Basin Water Quality Management Plan (S-J1)

Winhall River	Off Goodaleville Rd	Private	Jamaica	1989 Upper West River Basin Water Quality Management Plan (S-J2)
Wardsboro Brook	Off South Wardsboro Rd	Town Parcel	Wardsboro	1989 Upper West River Basin Water Quality Management Plan (S-W1)
Waterbody	**Site**	**Location of Use**	**Town**	**Documentation of Existing Use**
Rock River	Rock River confluence to 1 mi upriver, including Indian Love Call	Town legal trail along Depot Rd. w/ access easement	Newfane	Series of swimming holes from mouth to 1 mile up river
Utley Brook	Rec area behind old cemetery	Town Parcel	Landgrove	1989 Upper West River Basin Water Quality Management Plan (S-L1)
Cobb Brook	Hamilton Falls	Jamaica State Park	Jamaica	Swimming hole in state park
North Branch Ball Mountain Brook	Pikes Falls	Jamaica Town Conservation Land	Jamaica	Swimming hole on town conservation lands
Williams River Watershed				
Williams River	Brockways Mills Falls	Off Williams Rd	Rockingham	
	Rainbow Rocks	off Green Mountain Turnpike	Chester	Swimming hole off Green Mountain Turnpike, road ROW
Middle Branch	Walking Bridge	Town Parcel	Chester	
Saxtons River Watershed				
	Sandy Beach	Above Rt 5 bridge off Saxtons River Trail	Westminster	
	Saxtons River Falls	Below falls under Rte 121 bridge crossing	Saxtons River village	Swimming hole at end of town road
	Stickneys Field	West off Saxtons River Village, VRC easement	Rockingham	
Connecticut River Watershed				
East Putney Brook	River Road Culvert	Below culvert crossing	Putney	Swimming hole off of town road
Broad Brook	Fort Dummer State Park	Off south trail	Guilford	State park

Recreational Boating

It is the Agency's long-standing stipulation that all lakes and ponds in the basin have existing uses of boating and so only boating locations on rivers are listed below. Several locations are good whitewater or flatwater boating stretches in the basin; some highly rated by the Vermont Paddlers Association, listed in the AMC or Vermont White Water Rivers.

Waterbody	Location of Use	Towns	Documentation of Existing Use
Williams River Watershed			
Williams River	Chester to Brockways Mills	Chester, Springfield, Rockingham	Rated as HIGHLY IMPORTANT for boating[1] Put In: VDFW Williams River Access jct. of Rts 10 & 103 Take Out: Portage above Brockways Mills Dam
		Rockingham to Connecticut River	Flatwater upstream to Parker Hill Rd bridge[2] Put In: Herricks Cove Take Out: Herricks Cove
Middle Branch Williams River	Five miles above Chester down to Chester center	Andover, Chester	Rated as HIGHLY IMPORTANT for boating[1] Put In: Rte. 11 bridge crossing east of Hill Top Rd. Take Out: Pull off at Jct. of Rte's 11 and 103
Saxtons River Watershed			
Saxtons River	Grafton to Saxtons River village	Grafton, Rockingham	Rated as HIGHLY IMPORTANT for boating[1] Put In: Windham Fdtn park on South Branch 0.5 miles up from confluence with the Saxtons mainstem Take Out: Rte. 121 left bank road pull off 0.3 mi. upstream of Pleasant Valley Rd jct.
Saxtons River	Saxtons River village to Connecticut River	Rockingham	National Whitewater Inventory, American Whitewater listing[3] Put in: Town parcel at jct of 121 & Westminster St. Take Out: Barbers Park Rd. bridge
Connecticut River Watershed			
Connecticut River	Springfield to Brattleboro	Springfield, Rockingham, Westminster, Dummerston, Brattleboro	VDFW Access Areas: Hoyts Landing - Use Volume = Heavy Putney Landing - Use Volume = Light Dummerston Landing - Use Volume = Moderate Old Ferry Road - Use Volume = Heavy

			Other Official Access Areas: Herrick's Cove Picnic Area & Boat Launch Bellows Falls Bridge Portage Bellows Falls Historical Society River Access Retreat Meadows Broad Brook Access

[1] Source: Jenkins & Zika, 1992

[2] Personal Comm. M.L. Caduto

[3] American Whitewater: http://www.americanwhitewater.org/content/River/state-summary/state/VT/

Fishing

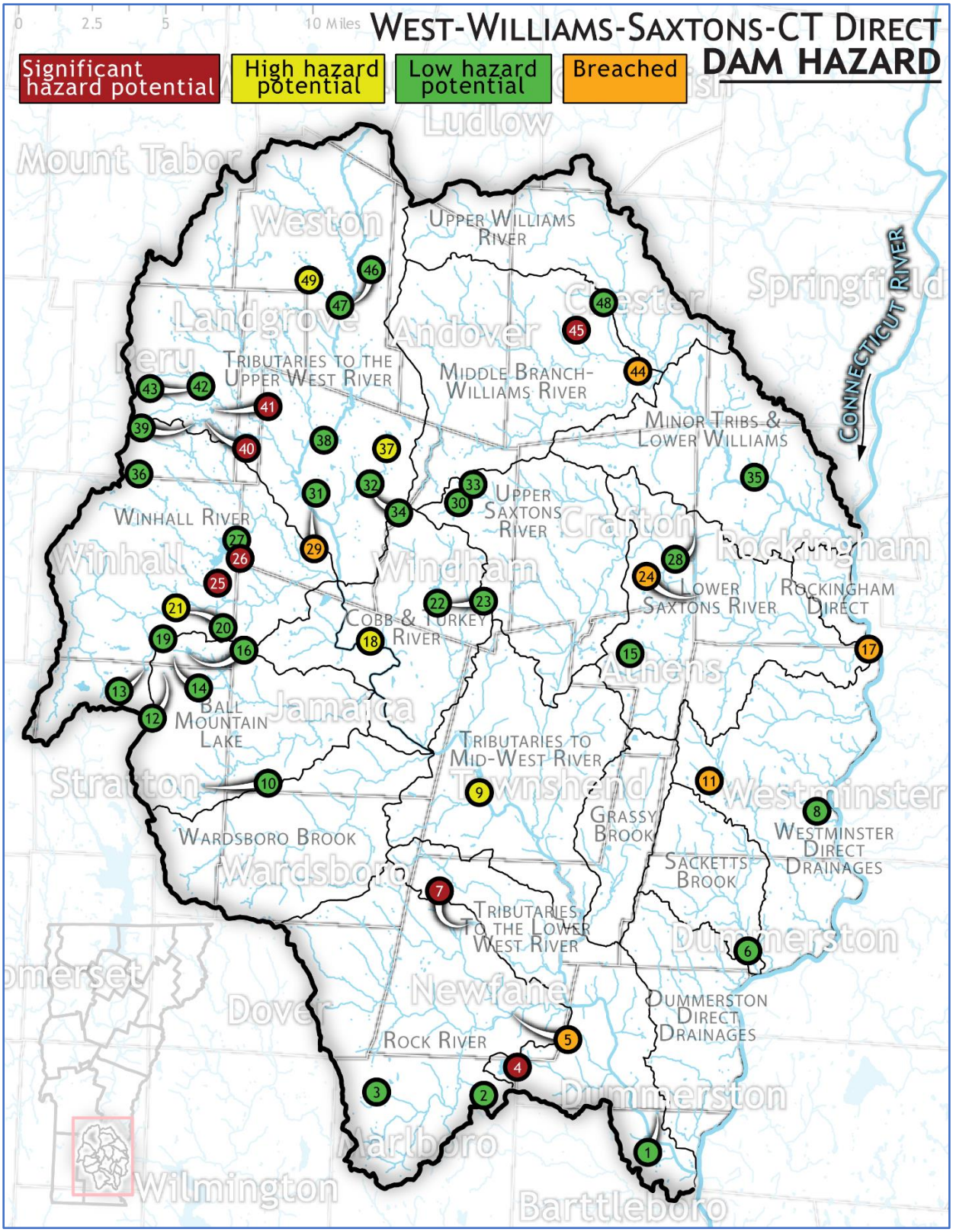
Waterbody	Location of Use	Town	Documentation of Existing Use
West River			
- confluence	Confluence with the Connecticut River to Rte 5 bridge	Brattleboro	Special Fishing Regulation Area
- lower	Rte 5 bridge above confluence with the Connecticut River to Townshend Dam	Townshend, Jamaica	Special Fishing Regulation Area
- middle	Above Townshend Dam to Rte 100 bridge in Jamaica	Townshend, Jamaica	Special Fishing Regulation Area
- upper	Cobb Brook to Jamaica State Park entrance bridge	Jamaica	Trout Stocking
Williams River			
- confluence	Mouth to first Rte 5 bridge above confluence with the Connecticut River	Rockingham	Special Fishing Regulation Area
- lower	First Rte 5 bridge above confluence with the Connecticut River to above Brockways Mills Dam	Rockingham	Special Fishing Regulation Area
Saxtons River			
- confluence	Mouth to first Rte 5 bridge above confluence with the Connecticut River	Westminster	Special Fishing Regulation Area
Connecticut River			
	All waters of the river including the bays, set backs and tributaries, up to the first highway bridge crossing said tributaries on the Vermont and New Hampshire sides	several	Special Fishing Regulation Area

Appendix C. Dams in Basin 11

Map ID #	Dam Name	Stream	Town	Surface Acres	Status	Purposes	Hazard Class
1	Brattleboro-2	West River-TR	Brattleboro	3.4	In Service	NA	Low
2	Ennis	Marlboro Branch-TR	Marlboro	0.6	In Service	Recreation	Low
3	Manley	Worden Brook-TR	Marlboro	3	In Service	Recreation	Low
4	Sunset Lake	Stickney Brook	Marlboro	95	In Service	Water Supply	Significant
5	Williamsville	Rock River	Newfane		Breached	NA	Breached
6	Sacketts Brook	Sacketts Brook	Putney	0.6	In Service	NA	Low
7	Kenny Pond	Baker Brook-TR	Newfane	20	In Service	Recreation	Significant
8	Westminster-1	Fullum Brook-TR	Westminster	0.1	In Service	Recreation	Low
9	Townshend	West River	Townshend	100	In Service	Flood Control and Stormwater Management, Recreation	High
10	Cole	Ball Mountain Brook-TR	Stratton	5	In Service	NA	Low
11	Stewart	East Putney Brook-TR	Westminster		Breached	NA	Breached
12	Stiles Brook Reservoir	Gulf Brook	Stratton	0.9	In Service	NA	Low
13	Gulf Brook Reservoir	Gulf Brook	Stratton	6	In Service	Other	Low
14	Stratton Mountain Lagoon	NA	Winhall	2	In Service	NA	Low
15	Athens Pond	Athens Brook-TR	Athens	21	Breached	NA	Low
16	Stratton Mountain Lake	North Branch Brook-TR	Winhall	18	In Service	Recreation	Low
17	Blake & Higgins	Saxtons River	Westminster		Breached	NA	Breached
18	Ball Mountain	West River	Jamaica	85	In Service	Flood Control and Stormwater Management, Recreation	High
19	Stratton WWTF Lagoon	North Branch Ball Brook-TR-OS	Winhall	1.4	In Service	Recreation	Low
20	Mahoney Pond Diversion Structure	Winhall River	Winhall	0	In Service	Recreation	Low
21	Mahoney Pond	Winhall River-OS	Winhall	15	In Service	Recreation	High

Map ID #	Dam Name	Stream	Town	Surface Acres	Status	Purposes	Hazard Class
22	Windham-3	Turkey Mountain Brook	Windham	0.8	In Service	NA	Low
23	Burbee Pond	Turkey Mountain Brook	Windham	34	In Service	Recreation	Low
24	Cambridgeport	Weaver Brook	Rockingham	5	Breached	NA	Breached
25	Strattonwald	Red Brook	Winhall	4	In Service	Recreation	Significant
26	Gale Meadows	Mill Brook	Londonderry	195	In Service	Recreation	Significant
27	Gale Meadows Dike	Eddy Brook-TR	Winhall	204	In Service	Recreation	Low
28	Holbrook	Weaver Brook	Grafton	7	In Service	Recreation	Low
29	Melendy Bridge	West River	Londonderry		Breached	NA	Breached
30	Lawrence Four Corners	Saxtons River	Windham	1.9	Breached (Partial)	NA	Low
31	Thomson	West River-OS	Londonderry	5	In Service	NA	Low
32	Magic Mountain	West Brook-TR	Londonderry	3	Breached (Partial)	Recreation	Low
33	Hamm Mine	Saxtons River-TR	Windham	8	In Service	Other	Low
34	Magic Mountain Lagoon	West Brook-TR - OS	Londonderry	1.3	In Service	NA	Low
35	Brockway Mills	Williams River	Rockingham	4	In Service	Hydroelectric	Low
36	Bromley Snow Pond	Mill Brook-TR	Peru	5	In Service	Other	Low
37	Lowell Lake	West River-TR	Londonderry	100	In Service	Recreation	High
38	Williams	West River	Londonderry	8	In Service	Other	Low
39	Lyons Pond	Burnt Meadow Brook	Peru	3	In Service	NA	Low
40	Newman	Burnt Meadow Brook	Peru	10	In Service	Recreation	Significant
41	Farnum	Farnum Brook	Peru	7	In Service	Recreation	Significant
42	Hapgood Pond Dike	Flood Brook-TR	Peru	4	In Service	Recreation	Low
43	Hapgood Pond	Flood Brook	Peru	4	In Service	Recreation	Low
44	South Branch	Williams River	Chester		Breached	NA	Breached
45	Upper Chester Reservoir	Williams River-TR	Chester	5	In Service	Recreation, Other	Significant
46	Weston Mill	West River	Weston	4	In Service	Fire Protection	Low
47	Weston (Upper)	West River-TR	Weston	0.1	In Service	NA	Low
48	Tomasso	Williams River-TR	Chester	3	In Service	Recreation	Low
49	Wantastiquet Lake	West River-TR	Weston	45	In Service	Recreation	High

Figure 26. Hazard Class of Dams



VERMONT

Appendix D. – West, Williams, Saxtons, Watersheds and lower Connecticut Tributaries (Basin 11) Fisheries Assessment

State of Vermont *Agency of Natural Resources*
Fish & Wildlife Department
100 Mineral Street, Suite 302 [cell] 802-777-0827
Springfield, VT 05156-3168 [fax] 802-885-8890
www.vtfishandwildlife.com [email] lael.will@vermont.gov

Memorandum

TO: Marie Caduto, Watershed Coordinator

FROM: Lael Will, Fisheries Biologist

DATE: 12/02/2020

SUBJECT: West, Williams, Saxtons, Watersheds and lower Connecticut Tributaries (Basin 11) Fisheries Assessment

West, Williams, Saxtons and lower Connecticut tributaries Fisheries:

The West, Williams, and Saxtons watersheds and southern tributaries to the Connecticut River provide habitat for a variety of warm and cold-water species. The waterbodies in the watershed include reservoirs serving for flood control and hydropower operation, lakes and ponds which provide warmwater fisheries, small headwater streams providing cold-water habitat for trout, and large mainstem rivers which provide spawning and rearing habitat for Connecticut River diadromous species. Sea Lamprey (*Petromyzon marinus)*, American Eel (*Anguilla rostrata)* and American Shad (*Alosa sapidissima)* utilize the West, Williams, and other Connecticut River tributaries to spawn and rear, and all are designated Species of Greatest Conservation Need (SGCN).

West River Drainage

Mainstem-

The West River is the largest drainage basin in this district with a watershed size of 423 square miles. The river is 46 miles long and flows through the towns of Mt. Holly, Weston, Londonderry, Jamaica, Townshend, Newfane, Dummerston, and Brattleboro where it meets the Connecticut River. The headwaters begin in Mount Holly on a tract of land known as "McLean parcel". Sampling conducted in June 2019 demonstrated that brook trout occupy the very upper

reaches of this watershed (Figure 1). Brook and brown trout occur in the mainstem but at relatively low abundances (Figures 2-3), however, there has been no sampling in recent years.

Diadromous species such as Sea Lamprey and American Eel can ascend the river up to Townshend Dam, and Sea Lamprey spawning has been documented downstream of Townshend Dam. Juvenile lamprey and American shad have been found rearing in Retreat Meadows, a setback to the Connecticut River located at the mouth of the West River. Other species that occur in the West River mainstem include Blacknose Dace (*Rhinichthys atratulus*), Common Shiner *(Luxilus cornutus),* Creek Chub *(Semotilus atromaculatus),* and as well as other species commonly found throughout the District (Table 1).

The West River drainage was historically part of the Atlantic Salmon Restoration Program which included the stocking of millions of Atlantic Salmon fry. The program ended in 2013 due to the lack of returns and the destruction of the White River National Fish Hatchery after T.S. Irene. No wild Atlantic salmon currently occur in the West River drainage.

There are four mainstem dams in the towns of Weston (Weston Mill Dam), Londonderry (Williams Dam), Jamaica (Ball Mountain Dam) and Townshend (Townshend Dam). These dams block fish passage and alter natural riverine processes including sediment and nutrient transport. Impoundments such as these also elevate temperatures thus degrading cold water habitats required for riverine species such as trout. Consideration should be given to removing the two upstream dams (Weston Mill and Williams), which would provide habitat connectivity and access to the cooler headwaters.

Water temperatures in the mainstem have been recorded periodically. Although these data are not recent, they provide some information relative to the conditions in the West River, and indicate warm temperatures in the summer months, with multiple sample locations recording temperatures above 80(Table 2). Given the impacts of climate change, it is likely that mean and maximum temperatures in the mainstem are even higher now.

Reservoirs- Ball Mountain, Townshend Lake

Ball Mountain and Townshend reservoirs impound the West River for Army Corps of Engineers Flood Control operations. Ball Mountain reservoir is 75 acres and varies in elevation depending on the season. The Department has not sampled Ball Mountain reservoir to assess the fish community. The river downstream of the Ball Mountain Dam, which runs through Jamaica State Park is stocked with rainbow trout.

Townshend reservoir is 95 acres and is stocked with rainbow trout. In 2011, sampling via boat-mounted electrofishing collected Smallmouth Bass (*Micropterus dolomieu)*, Yellow Perch (*Perca flavescens),* Pumpkinseed (*Lepomis gibbosus),* White Sucker (*Catostomus commersonii),* Brown Bullhead *(Ameiurus nebulosus),* Fallfish (*Semotilus corporalis),* Golden Shiner (*Notemigonus crysoleucas),* and Common Shiner. Tropical Storm Irene deposited a substantial amount of sediment behind the dam reducing the quality and quantity of aquatic habitat.

In 2014, both dams were retrofitted to accommodate a hydroelectric facility with a surface bypass system to allow fish to navigate past the dam without going through the turbines, and thus reduce fish mortality and project impacts.

The Army Corps West River white-water recreational releases that occur in the spring and fall have been an area of concern considering the Corps has not been in compliance with the Agency's flow agreement since 2014. The flow management during these events has caused fish stranding as evidenced by surveys conducted by VTFWD (see attached memo). The Connecticut River Atlantic Salmon Commission (CRASC) sent the Army Corps of Engineers a letter in 2016 identifying their resource concerns associated with these recreational releases (see attached memo). To date, attempts to resolve the issue have been unsuccessful and the Corps continues to operate Ball Mountain in a manner that negatively impacts the aquatic resources that reside in the West River.

Headwater streams-

Small headwater streams that provide habitat for native brook trout are found throughout the West River basin (Figures 4-5). Many of these streams are sampled routinely to as part of district-wide trout population monitoring (Figure 6). Sites that meet the B1[49] Fishing Criteria[1] include Baker Brook, Dover Brook, Fair Brook, Farnum Brook, Greendale Brook, Pike Hollow, Rock River, Utley Brook, Waite Brook (Table 3).

Long term data collected indicates that while smaller size classes tend to fluctuate annually, adult populations have remained relatively stable through time (Figures 7-22). Some sites, such as the headwaters of Ball Mountain (Figures 8-9) and Pike Hollow (Figures 13-14), have recently been occupied by brown trout concurrent with reductions in brook trout abundances. While specific reasons for this are unknown, warming stream temperatures likely play a role, reducing suitable habitat for brook trout and allowing brown trout to capitalize on warmer water areas.

Stream temperatures are also monitored at representative sites throughout the watershed (Figure 23-27). Sites such as the headwaters of the Rock River (Figure 26) and Fair Brook (Figure 25) have relatively constant cold temperatures, creating ideal habitat conditions for cold water riverine species such as brook trout.

Large Tributaries-

Large tributary streams include the Winhall River, Ball Mountain Brook, Marlboro Branch, Wardsboro Brook, and the Rock River. Consistent with other large tributary streams, the Winhall River does not support robust trout populations (Table 3). The Winhall River is also influenced by snow-making infrastructure and water withdrawals associated with the Stratton Resort.

[49] B(1) Fishing Use Criteria: Wild, self-sustaining salmonid populations which are capable of supporting multiple age classes totaling a minimum of 1000 per mile (all species/ages/sizes); and/or 200 per mile > 6 inches (total length); and/or 20 pounds/acre (all species/ages/sizes).

Ball Mountain Brook, Wardsboro Brook, and the Rock River support trout populations within the upper reaches, but similar to the Winhall River, the lower reaches do not provide habitat conditions conducive to robust trout populations (Table 3).

These mainstem rivers have been heavily modified due to post-Irene instream construction including berming, channelization, and armoring, which further limits the ability of these rivers to support healthy trout populations.

Ponds-

Gale Meadows, Lowell Lake, Retreat Meadows, Sunset Lake, Hapgood Pond, and Wantastiquet Lake are some of the more notable lentic waterbodies in the watershed.

Gale Meadows is a 195-acre pond located in Winhall. It is known for its largemouth bass fishery and has a VTFWD access area. The pond has been sampled periodically to monitor bass populations utilizing boat electrofishing since the mid-1990s (Figure 28).

in 2018, a fish community assessment was conducted in response to a spring fish kill (Figure 29). These efforts evaluating the potential effects of the fish kill on species composition and relative abundance of fishes in the pond. Results indicated that despite the fish kill, largemouth bass and other species such as Golden Shiner, Pumpkinseed and Yellow Perch were well represented in the community (Figure 30).

Although the direct cause of the fish kill in Gale Meadows is unknown, no evidence of a virus or toxic discharge was found, indicating that it is likely that water quality played a role. As water temperatures warm with climate change, shallow ponds can experience shifts in dissolved oxygen levels, potentially resulting in levels too low for fish survival. With continued climate change, these events are expected to become more frequent.

Lowell Lake is a 95-acre pond and is the dominant feature of Lowell Lake State Park. Lowell Lake has a maximum depth of 19ft and is relatively acidic. The average depth is likely less than 10 feet. Lake water level can be controlled by an earthen dam at the outlet but is maintained at a stable level (1,350.5 ft above mean sea level). Routine monitoring utilizing standardized boat electrofishing indicated that CPUE of largemouth bass in Lowell Lake is moderate and remained relatively unchanged from the last time sampling occurred in 2010 (Figure 31). Other species that occur in the lake include Golden Shiner, Brown Bullhead, Chain Pickerel *(Esox niger)*, Pumpkinseed, Largemouth Bass, and Yellow Perch.

Retreat Meadows is an approximately 80-acre setback of the West River in Brattleboro located just upstream the confluence with the Connecticut River. The waterbody provides important spawning and rearing habitat for a variety of species and is a popular year-round fishery. Fisheries investigations have been conducted by VTFWD in 1995,1996, 2017, 2018 and in 2015 by Normandeau Associates during FERC relicensing investigations. These data indicate that the waterbody provides habitat for over 20 species of fish including American shad, American eel, and sea lamprey (Table 4). Creel survey data collected in 2018 indicate that over 4000 (+/- 1519)

fish were caught via ice fishing. Bass electrofishing indicated a decrease in catch rates between 1996 and 2017 (Figure 32), likely due to T.S. Irene sedimentation.

Impacts to this ecologically important waterbody include post-Irene sedimentation and water level fluctuations during the spawning period that can dewater incubating eggs. It is anticipated that magnitude and frequency of these water level fluctuations will be reduced under the new FERC license for the Vernon project.

Hapgood Pond is 12 acres in size and is located in Peru. The pond impounds Flood Brook, a tributary to the West River. It is managed by the US Forest Service and provides recreational opportunities including fishing, and the VTFWD stocks yearling brook trout. Each year the pond is drained, which negatively impacts the biota within the pond as well altering flow and sediment discharges to the receiving waters (Flood Brook). Efforts to improve the management of the pond should be discussed with the U.S. Forest Service.

Williams River Drainage

The Williams River is 27 miles long and has a drainage area of 117 square miles. The headwaters originate in Andover and the river flows through the towns of Chester, portions of Ludlow, and Rockingham. The Middle Branch and South Branch originate in Windham.

The Williams River drainage was historically part of the Atlantic Salmon Restoration Program which included the stocking of millions of Atlantic Salmon fry. The program ended in 2013 due to the lack of returns and the destruction of the White River National Fish Hatchery after T.S. Irene. No wild Atlantic salmon occur in the Williams river drainage.

Trout monitoring within the basin is limited but includes the mainstem, South Branch, Middle Branch, and Andover Branch (Table 5). The Andover Branch historically had robust trout populations, but recent sampling indicated a decline (Figure 33). The site, however, meets the B1 Fishing Criteria.

Similarly, the South Branch of the Williams is monitored annually for trout abundances and stream temperatures. These data indicate that stream temperatures can get warm during the summer months, and trout abundances remain relatively low (Figures 34-36). Warm stream temperatures are characteristic of the watershed.

Other species that occur in the watershed include Blacknose Dace (*Rhinichthys atratulus)*, Brown Bullhead, Common Shiner, Creek Chub (*Semotilus atromaculatus)*, Fallfish, Lake Chub (*Couesius plumbeus)*, Longnose Dace (*Rhinichthys cataractae*), Longnose Sucker (*Catostomus Catostomus*), Slimy Sculpin *(Cottus cognatus),* Smallmouth Bass, Tessellated Darter (*Etheostoma olmstedi*), and White Sucker.

Brockways Mills is a hydroelectric dam located about 5 miles upstream from the confluence with the Connecticut River. The dam is 8 feet in height and is situated on a natural 30-foot cascade. It

is not likely that diadromous species such as sea lamprey, and American eel are able to migrate past the falls and dam, and they have not been observed above the dam. Sedimentation upstream of the dam has degraded riverine habitats.

Herricks Cove at the mouth of the Williams River is a setback to the Connecticut River and provides unique habitat conducive to spawning and rearing of fishes that occupy the mainstem. For example, Northern Pike *(Esox Lucius)* spawn in shallow, well vegetated waters that border rivers in ponds. Historic fish sampling indicates that smallmouth bass, lake chub, white sucker, and chain pickerel occupy the cove, and it is likely that many other species utilize this habitat as well. Efforts to evaluate the current fish assemblage in this water body should be pursued.

Saxtons River Drainage

The Saxtons River is 23 miles long and has a drainage area of 78 square miles. The river originates in Windham and flows through the towns of Grafton, Cambridgeport, Saxtons River, and Westminster.

Trout population monitoring has occurred in Bull Creek, Howe Brook, Leach Brook, the South Branch and the Mainstem (Table 6). Bull Creek is the only site that could potentially meet the B1 Fishing Criteria pending additional sampling. The mainstem and South Branch contain very low numbers of trout likely due to warm temperatures. Other species that occur in the river include blacknose dace, common shiner, creek chub, fallfish, lake chub, longnose dace, rock bass, slimy sculpin, and white sucker.

The upper mainstem (Saxtons1052) is sampled annually concurrent with stream temperatures (Figures 37-39). Trout abundances in this reach increased after T.S. Irene likely due to some downed trees that spanned the channel width. The benefits of instream woody debris has been well documented as providing valuable cover, increasing habitat complexity, and retaining sediment, thereby improving the habitat suitability for trout. As the wood deteriorated over time, trout abundances declined in this section (Figures 37-38).

The South Branch and mainstem lack adequate riparian corridors and were heavily impacted due to post-Irene construction. Much of the instream habitat such as wood, and large boulders were removed, and berms were constructed (Figures 40-43). Consequently, warm water temperatures, and lack of instream habitat contributes to the low abundances of trout in these rivers.

Lower in the river, Twin Falls, located about 1 mile upstream from the mouth is a natural barrier. A partially breached dam (Blake Higgins Dam) occurs just below the Rte 5 bridge and is considered a barrier for most species. Removal of the remainder of the dam would provide access to good spawning habitat that occurs between Twin Falls and the mouth.

Connecticut River Tributaries

Connecticut River tributaries are ecologically important due to their direct connection to the mainstem. These streams provide important spawning and rearing habitat, as well as thermal refuge during the warm summer months. Streams such as Canoe Brook, Chase Brook, Crosby Brook, East Putney Brook, Morse Brook, Sacketts Brook, and Salmon Brook have been sampled by the VTFWD , and several of these sites meet the B1 Fishing Criteria (Table 7). American eel have historically been observed in Sacketts Brook, and rainbow trout occupy East Putney Brook and Morse Brook. Considering their connection to the mainstem and habitat requirements for diadromous species such as sea lamprey, providing fish passage at man-made barriers should be a priority.

Resource Impacts within the Basin 11 River Watersheds (West, Williams, Saxtons, Ct River):

- ***Ski Resorts***

Resource impacts within these watersheds include intense development associated with ski resorts such as Stratton, Bromley, and Magic Mountain. Heavy development in sensitive mountain and headwater environments through the construction of resort infrastructure, clearing for ski trails, and development of mountain bike trail networks results in the loss of upland and riparian forest, changes to surface hydrology (e.g., due to snowmaking), creation of impassable stream crossings (e.g., undersized culverts), and increased erosion and sediment runoff are just a few of the ways in which these land uses can degrade water quality, impact natural stream processes, and threaten aquatic populations. As a result, many of the ski areas include impaired waterways such as Styles Brook (Stratton Mountain) and Mill Brook (Bromley Mountain) (https://dec.vermont.gov/watershed/map/assessment).

Snow-making infrastructure results in impediments to fish passage, alters the natural flow regime, and can cause bank erosion and scouring. Designing snow-making structures that are compatible with natural stream processes and provide for Aquatic Organism Passage (AOP), should be developed.

The Agency has been working on addressing the cumulative impacts of ski resort development through the Act 250 process, including developing comprehensive riparian management plans and replacing undersized culverts may improve water quality and reduce bank erosion..

- ***Dams***

It is well known that dams block fish passage and alter natural stream processes such as sediment and nutrient transport. As such, dam removal projects are an excellent restoration tool and have gained momentum in recent years. For example, restoration efforts at Magic Mountain resulted in the removal of a historic dam located on Thompsonburg Brook in 2019. Removal of this dam provides access to the upper watershed, where stream temperatures are cooler.

Mainstem dams such as the Williams Dam in Londonderry and the Weston Mill Dam in Weston block access to the upper portions of the West River. Similarly, the Blake Higgins Dam located on the Saxtons blocks access to valuable spawning habitat in the lower reach. Consideration should be given to their removal.

- ***Flow Alterations***

Flow Alterations associated with the Ball Mountain white-water release have been demonstrated to negatively impact aquatic biota. To date, the issue has not been adequately addressed.

Water withdrawals, in light of climate change, have the propensity to degrade aquatic habitats. For example, the *de minimus* rate, which is defined as 0.005 cubic feet per second per square mile of drainage area (csm) does not address cumulative impacts and drought conditions. In 2020, sites that historically met the B1 fishing criteria, were dry during this summer drought. During low flow years, maintaining water in these brooks is critical to the survival of aquatic species. Currently, the *de minimus* rate would allow for water withdrawals during drought years, adding further stress to the system.

- ***Riparian encroachments***

Riparian encroachments occur throughout these watersheds and are most profound along some of the mainstem rivers where roads have been constructed. Significant riparian zone encroachments occur on the mainstem West River along Rte 100 and Rte 30, the Winhall River along Rte 30, and River Road in Bondville, Saxtons River along Rte 121, Wardsboro along Rte 100, South Branch Saxtons along Rte 35, and all three branches of the Williams (Rte 11, Rte 103, and Rte 35). Managing these areas outside of the road right-of-way for native riparian vegetation would improve conditions. Similarly, bank stabilization to protect road infrastructure further reduces riparian vegetation. Installation of plantings (e.g., Willow stakes) after bank stabilization or culvert replacements should be considered.

Invasive species such as Japanesse knotweed *(Reynoutria japonica)* are widespread throughout these watersheds, particularly in the Williams and Saxtons. Preventative strategies such as inspecting and removing plants, fragments seeds from gear, clothing, vehicles and equipment and ensuring soil, gravel and other fill materials are not contaminated and subsequently moved are some ways to help stop the spread (Metro Vancouver Regional District 2019).

In these watersheds, the invasive plant tends to occupy habitats that have recently been disturbed or cleared (e.g., bank stabilization projects). Planting native vegetation shortly after riparian disturbance can help suppress colonization (Metro Vancouver Regional District 2019).

- ***Tropical storm Irene***

Tropical storm Irene occurred in August of 2011and resulted in the deposition of over six inches of rain in the central and south-eastern portion of Vermont. As a result, hundreds of bridges, road

segments, culverts, homes and other infrastructure suffered severe damage, and were in need of immediate repair. Post-flood activities required stream alteration to protect life and property and rebuild critical transportation infrastructure (Lunderville 2011). However, much of the in-stream work resulted in the widening, deepening and straightening of stream channels. In some cases, in-stream wood was removed, stream banks were bermed, and stream bed elevations were raised. As a result, aquatic habitats including a diversity of substrate types, depths, flows, and cover, necessary to support healthy fish populations, suffered severe negative impacts. In 2012, VTFWD staff conducted roadside assessment of instream habitat degradation throughout the central and southern portion of Vermont (Kirn 2012). An estimated 77 miles of streams were identified as being degraded from post-flood stream alteration activities. The Winhall River along River Road in Bondville is an example of how post-Irene construction has impacted natural stream processes. As such, the VTFWD has been actively working to restore reaches to more natural conditions. Efforts to continue stream restoration in these reaches are paramount as it may take decades before these streams recover.

Management Recommendations:

1. **Protect and restore riparian corridors:** Undisturbed, naturally vegetated buffer strips are extremely important in maintaining cool water temperatures and stable streambanks, filtering pollutants and providing food and shelter for fish and other aquatic organisms. These benefits are realized not only within the protected stream reach, but also in its downstream receiving waters. Providing outreach and education to private landowners on the benefits of riparian corridors would also benefit streams and should be promoted. Restoring riparian corridors and controlling invasive species at site specific projects should also be considered.

2. **Improve aquatic habitat connectivity:** Maintaining a connected system allows fish to seek the best available habitat for reproductive needs, food resources, thermal refuge and cover. Aquatic connectivity also allows for the recolonization of upstream habitats after catastrophic events, such as floods or toxic discharges. Furthermore, free movement within a river system helps to maintain genetic diversity of aquatic populations. During periods of stressful environmental conditions, fish will often migrate to cold-water refuges such as the mouths of tributary streams or to areas of groundwater inflow during warm periods. Providing aquatic connectivity by evaluating and replacing culverts which impede free movement, and continuing efforts to remove dams, would benefit resident species as well as diadromous species such as American eel, and Sea lamprey.

3. **Improve flood resiliency and restore post-Irene impacts.** Post-Tropical Storm Irene impacts, including berming, instream channelization, and removal of instream cover including boulders and wood inevitably impacted aquatic biota within the Basin 11 watersheds. Restoring instream complexity and access to floodplains would improve the overall quality of the system, leading to positive impacts on fish populations (Kirn 2012). Efforts should be made to identify sites and restore these reaches back to natural conditions. Examples include removing berms along Rte 35 in Grafton (Figures 40-43).

4. **Where flows are regulated, promote the natural flow regime:** Maintaining or improving flow management at hydroelectric, storage, and existing flood control facilities would benefit downstream species. Rapid fluctuations in flows can strand fish or displace them downstream. Fluctuations may also expose or destroy spawning areas containing eggs or newly hatched fish. Conversely, reduced peak discharges and generally stable flows produced by regulated water releases from flood control or storage reservoirs inevitably impact natural stream processes including channel morphology and substrate composition. The Ball Mountain white-water releases represent a departure from the natural flow regime and are inconsistent with the agreed upon flows and ramping rates during these scheduled events. Efforts should continue to rectify the situation.

5. **Stop the spread of exotic species and pathogens:** A variety of non-native fish species and harmful pathogens are present in Vermont or surrounding states. Preventing future introductions of these exotic species and pathogens will allow healthy fisheries to continue.

6. **Protect water quality.** Maintaining clear, cold, and well-oxygenated water is an important habitat requirement for trout. Activities that can have negative impacts to water quality (i.e. sediment discharges), should be avoided and/or minimized through evaluation of proposed projects. Considering VTFWD biologists provide input into several state-issued permits including stream alteration, and water quality certifications efforts to protect water quality are accomplished through several avenues. Additional efforts by interested partners to work with private landowners on riparian land stewardship will compliment state and federal regulatory efforts. Ski resorts should continue efforts to restore impaired waters.

7. **Identify and designate B1 High Quality Fishing – Wild Salmonid Streams**
Abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (brook, brown, or rainbow trout) at levels generally equal to or greater than 1,000 fish/mile and/or 20 pounds/acre. Streams designated as B1 are provided increased protection. Based on VTFWD data, streams that meet the B1 criteria include Baker Brook, Dover Brook, Fair Brook, Farnum Brook, Greendale Brook, Pike Hollow Brook, Rock River, Utley Brook, Waite Brook, Andover Branch, Canoe Brook, East Putney Brook, Morse Brook, and Salmon Brook. Other streams may be potential candidates but to date have not met the sampling requirements.

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Lunderville, N. 2011. Irene recovery report. A stronger future. A report to the Governor of Vermont.

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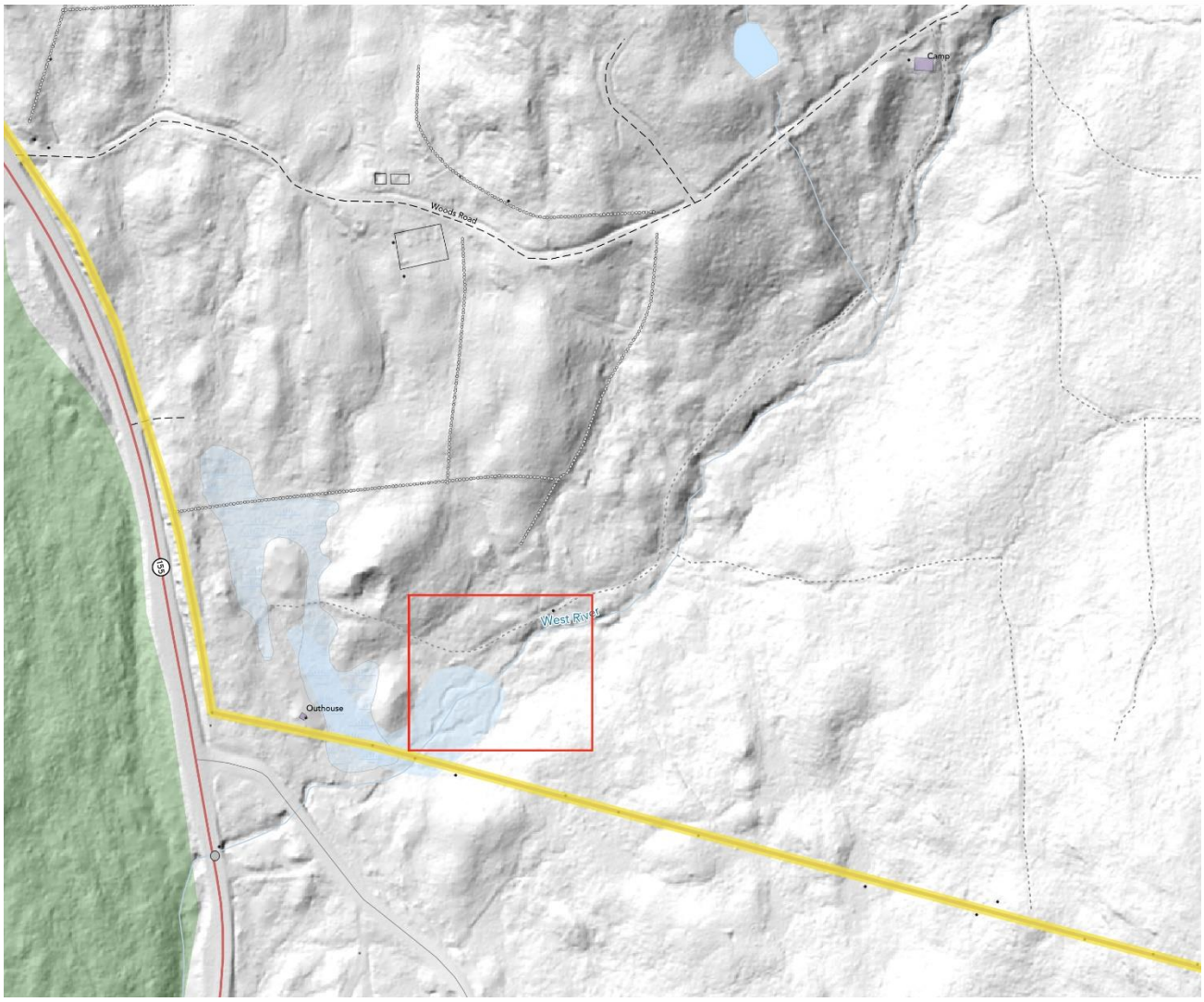


Figure 1. Headwaters of the West River, sampling 2019 on the "McLean Parcel".

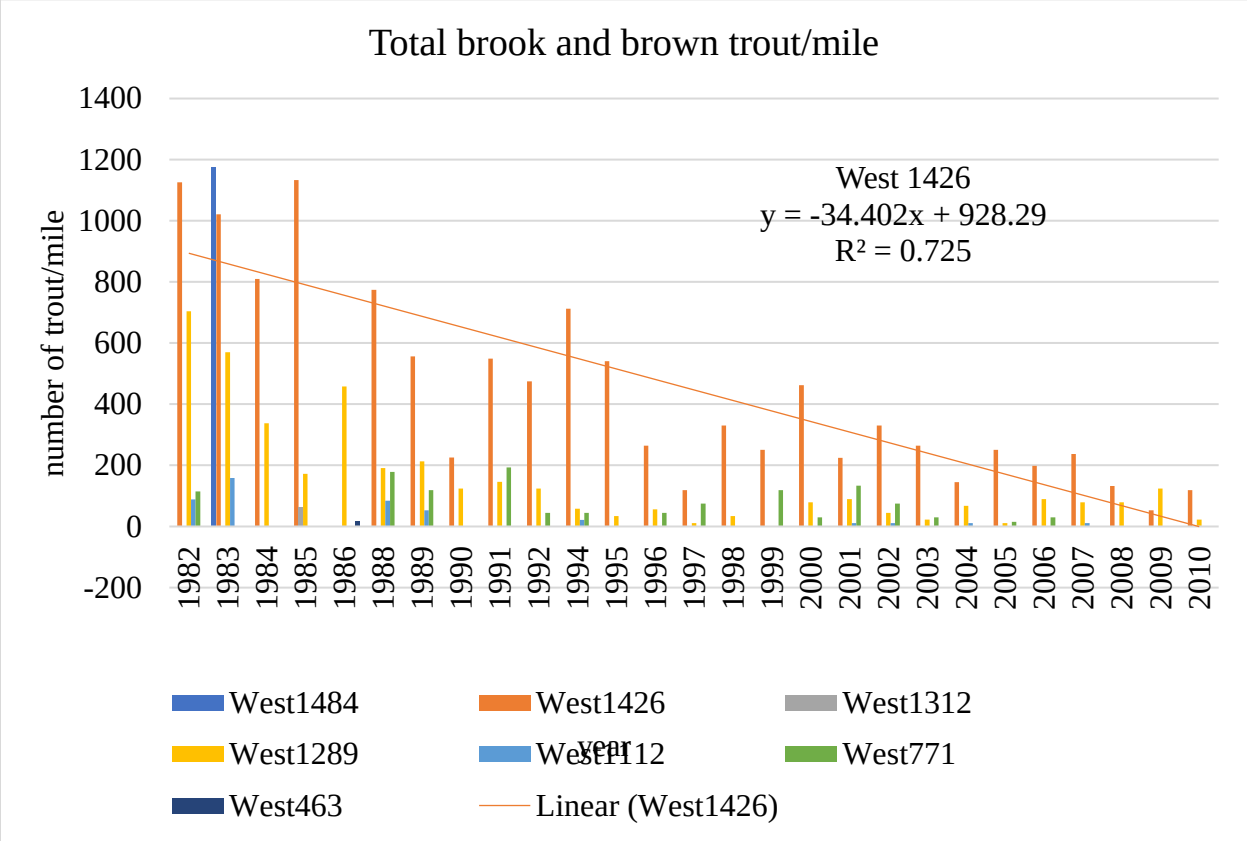


Figure 2. Mainstem trout abundances including brook and brown trout all size classes 1982-2010.

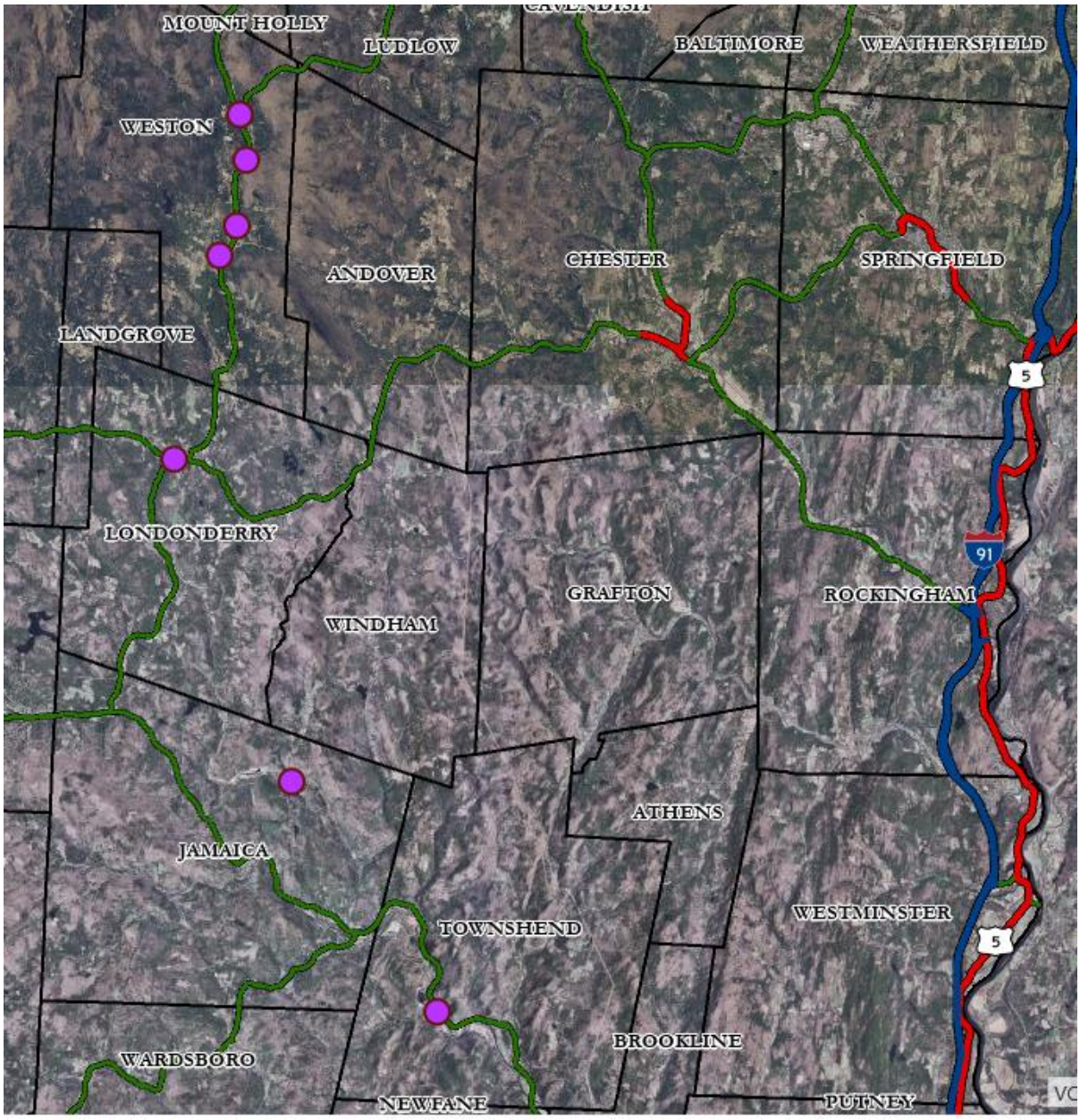


Figure 3. Sample locations on the mainstem West River from 1982-2010.

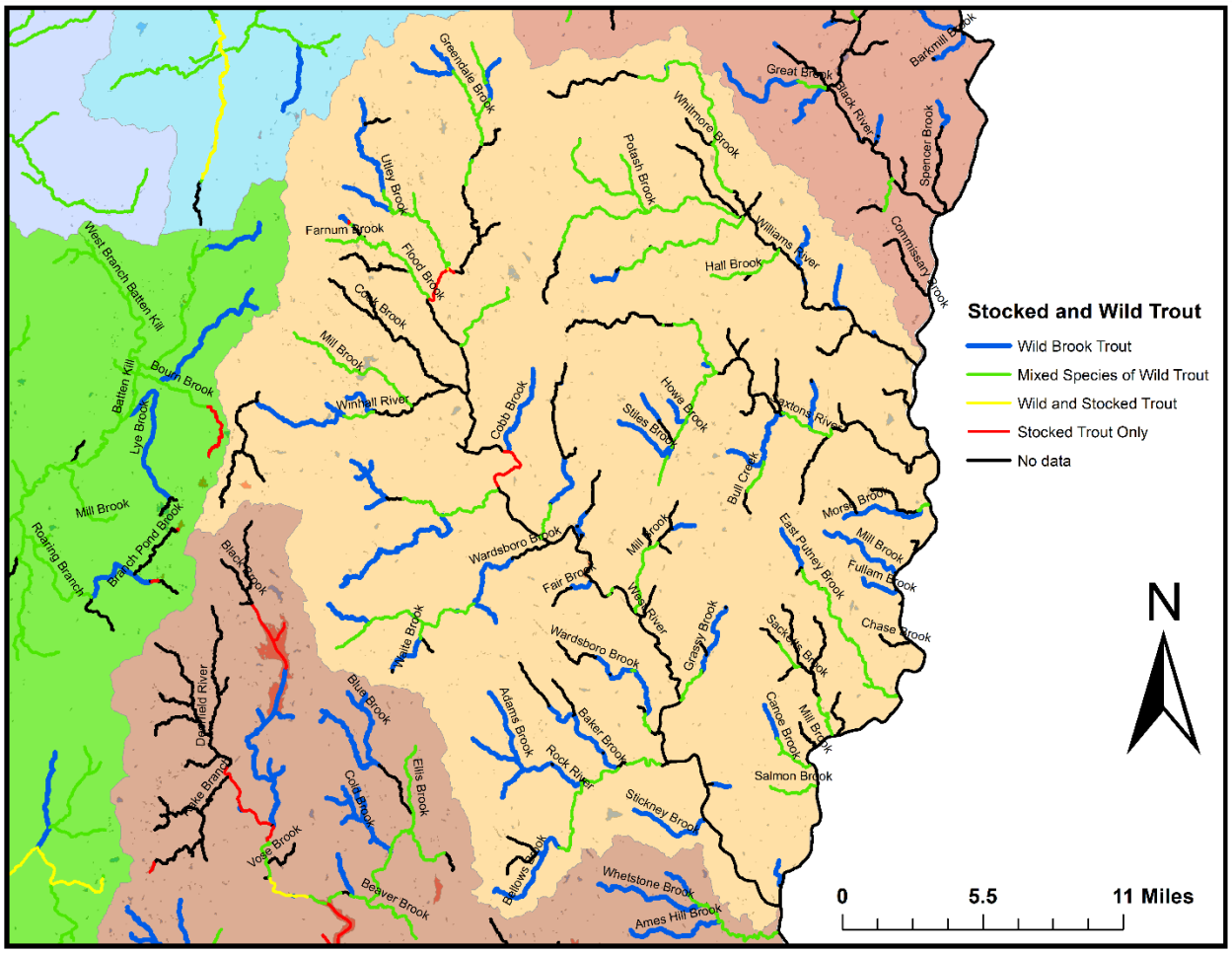


Figure 4. Streams providing habitat for trout within the Basin 11 watersheds.

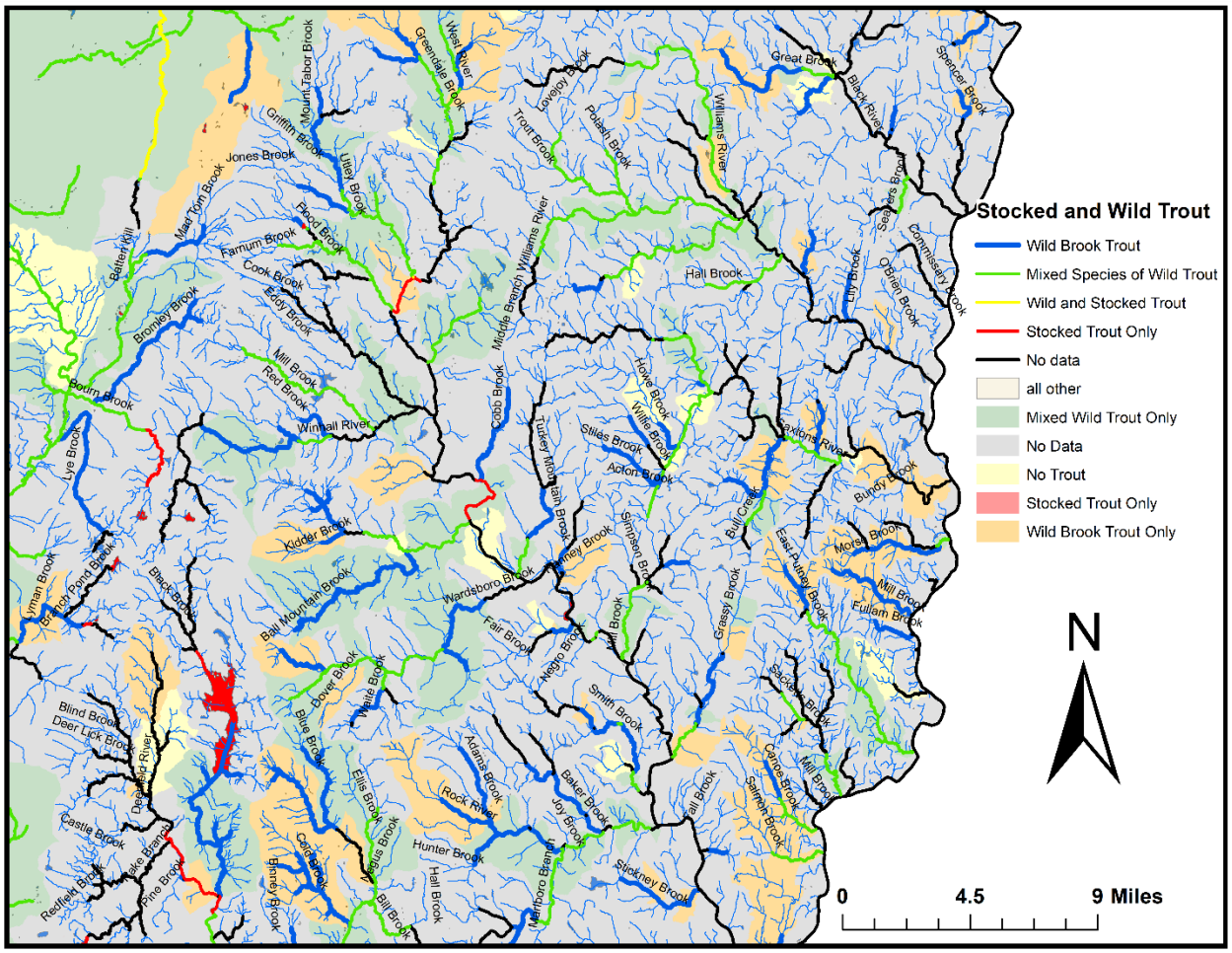


Figure 5. Catchments providing habitat for wild trout.

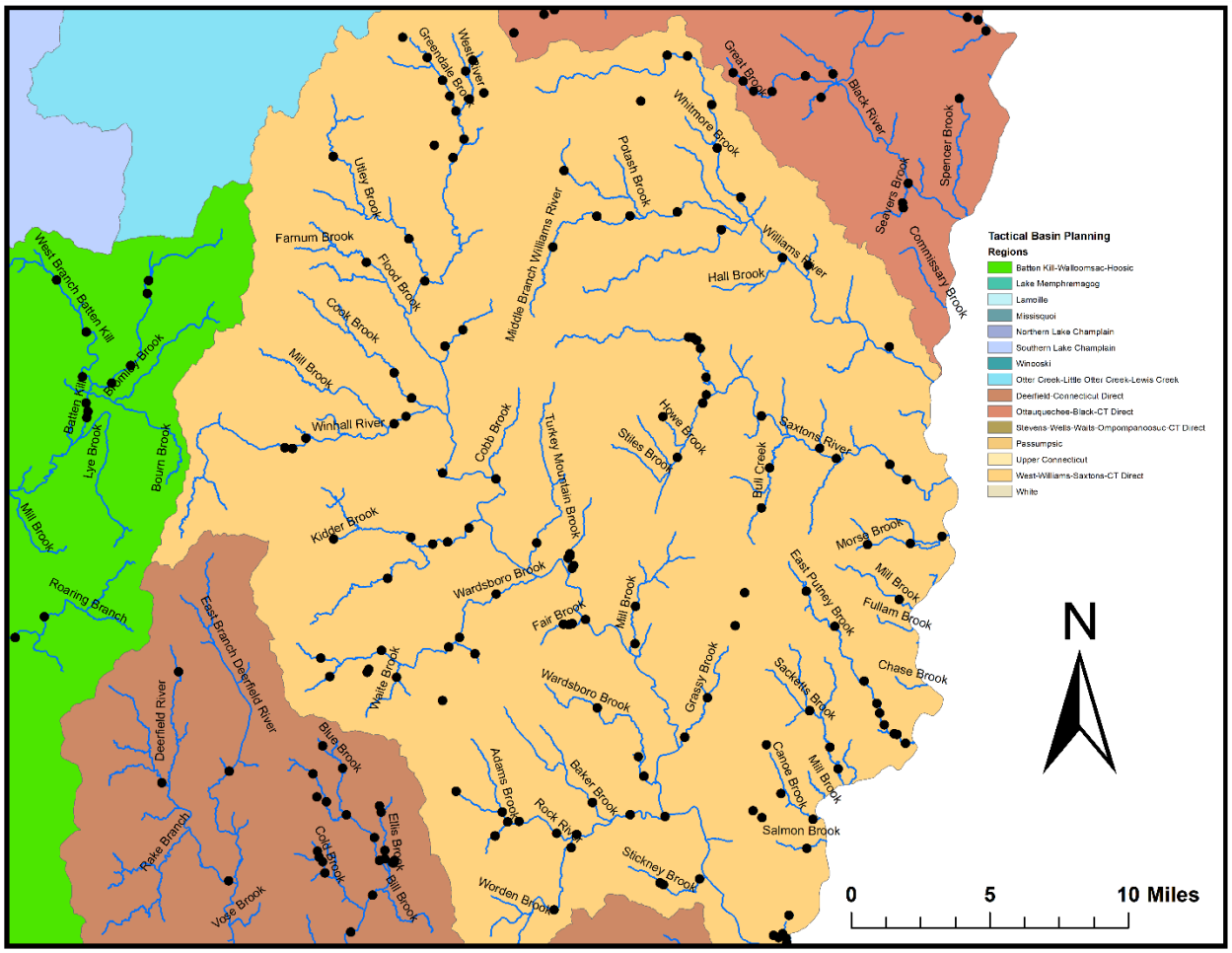


Figure 6. Trout population sampling sites throughout the basin.

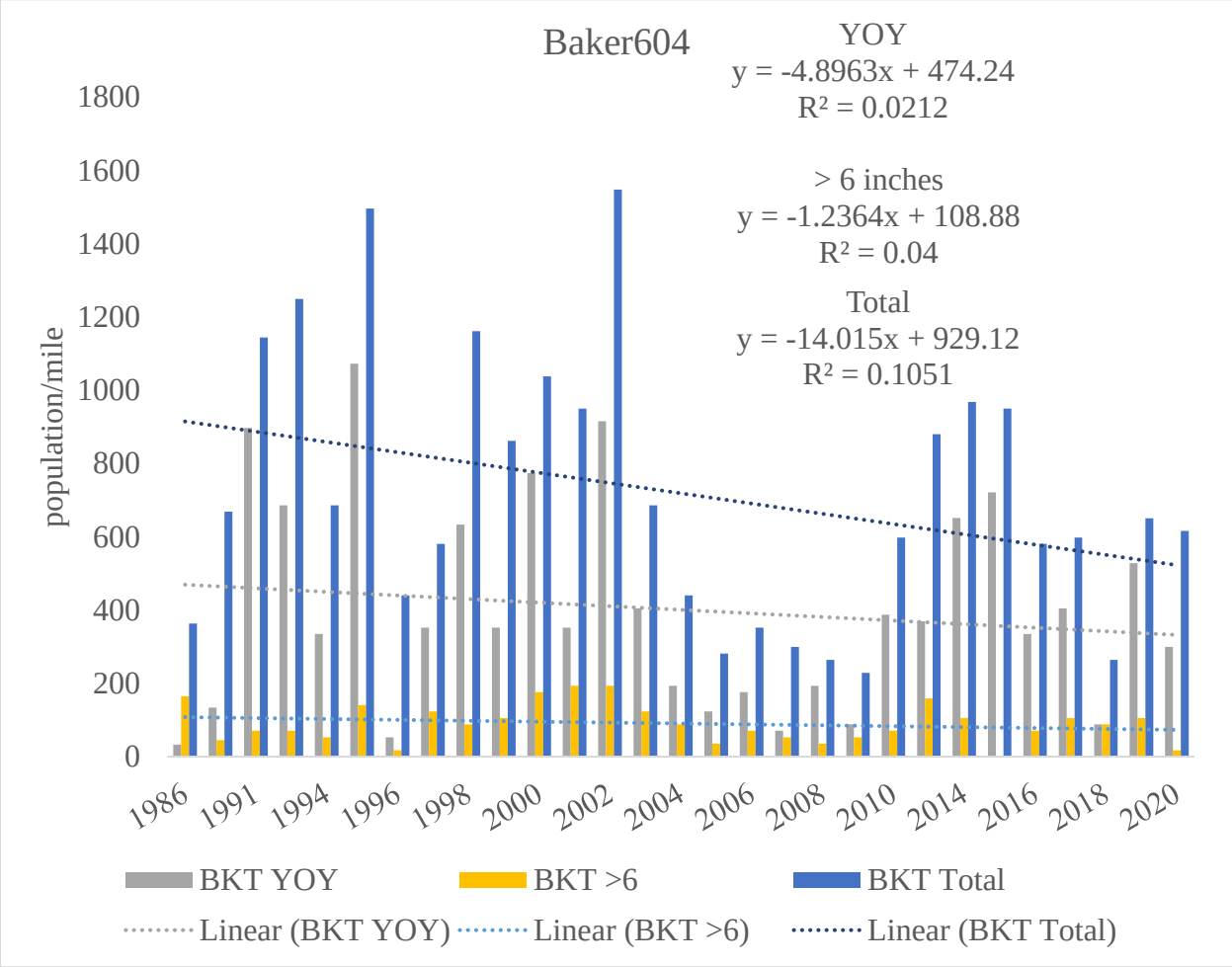


Figure 7. brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

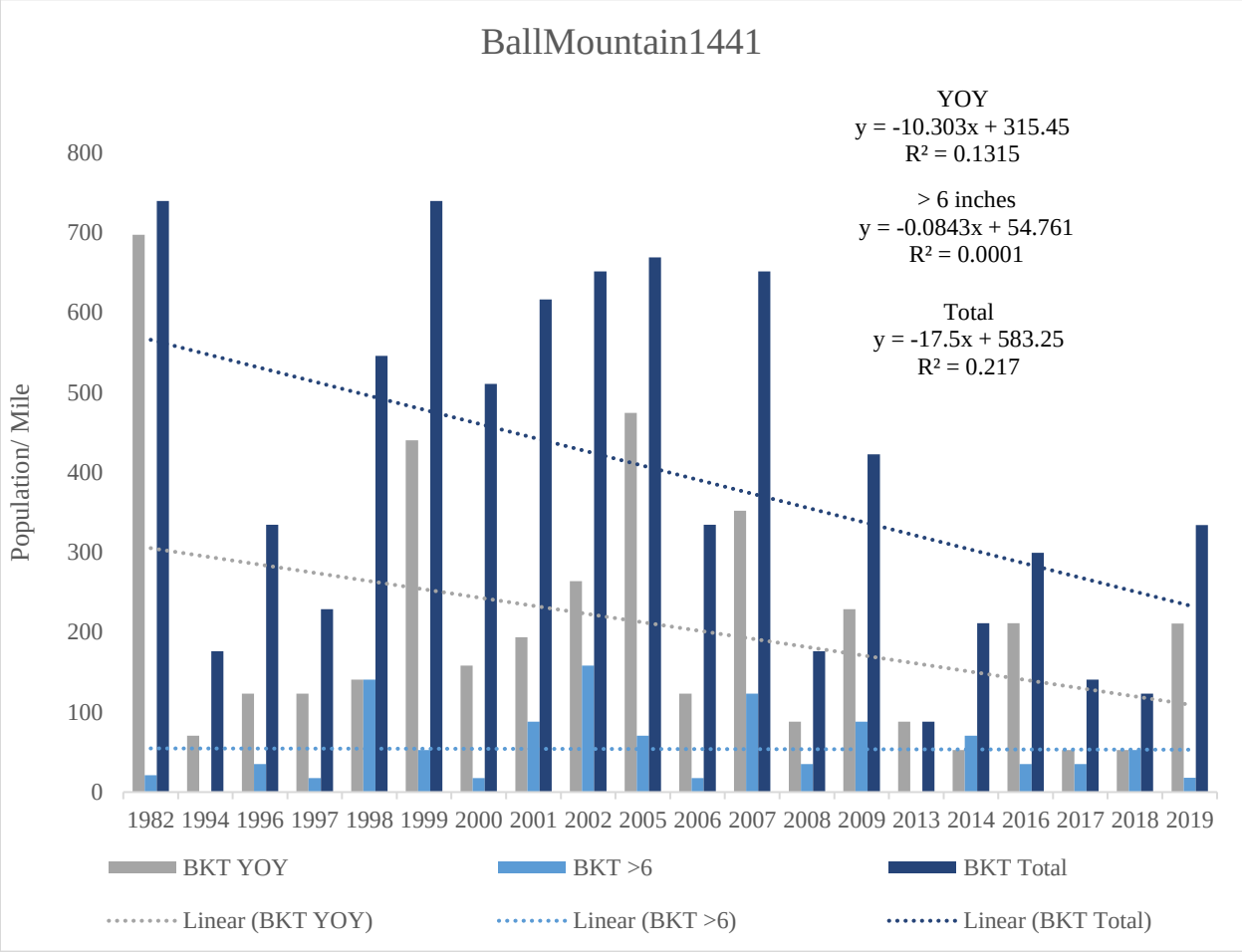


Figure 8. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

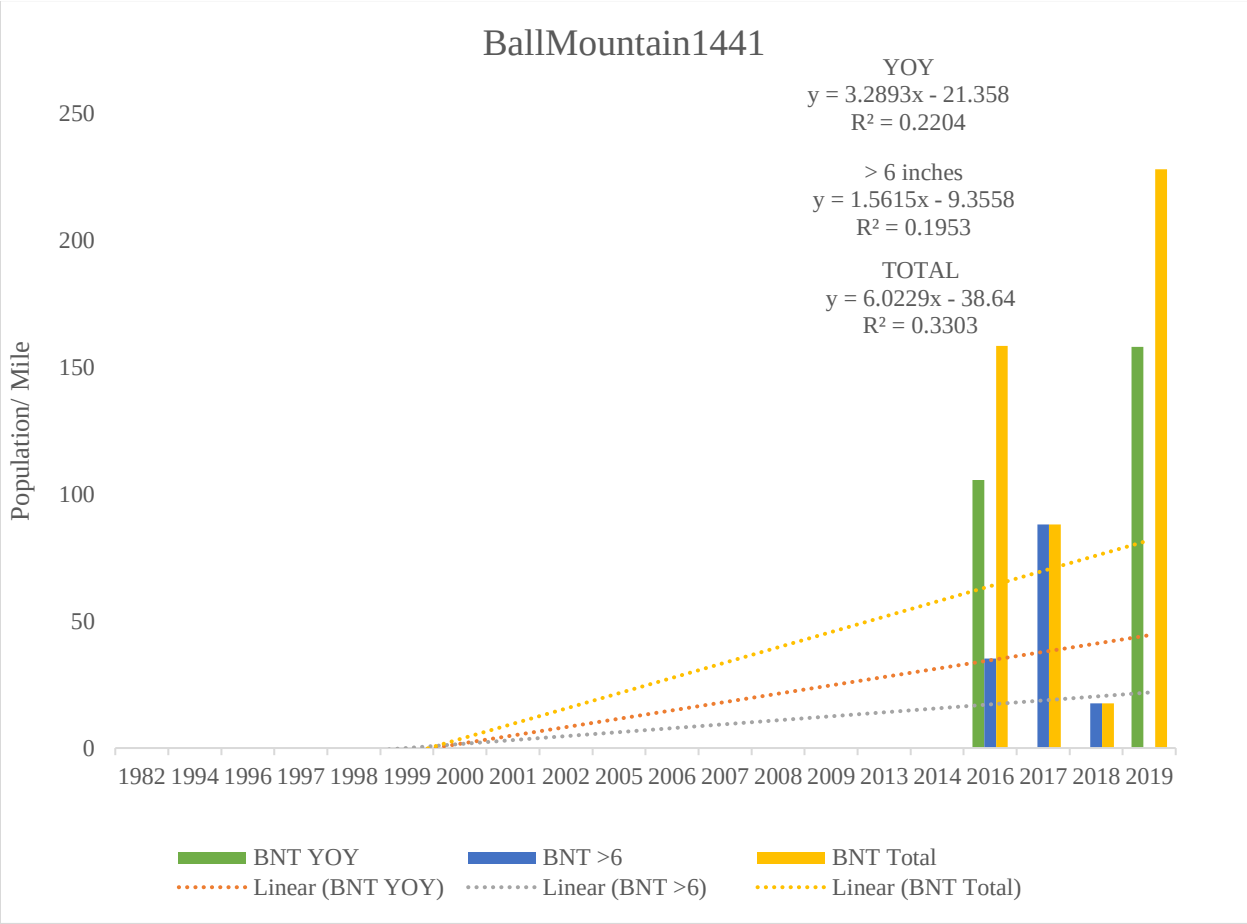


Figure 9. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

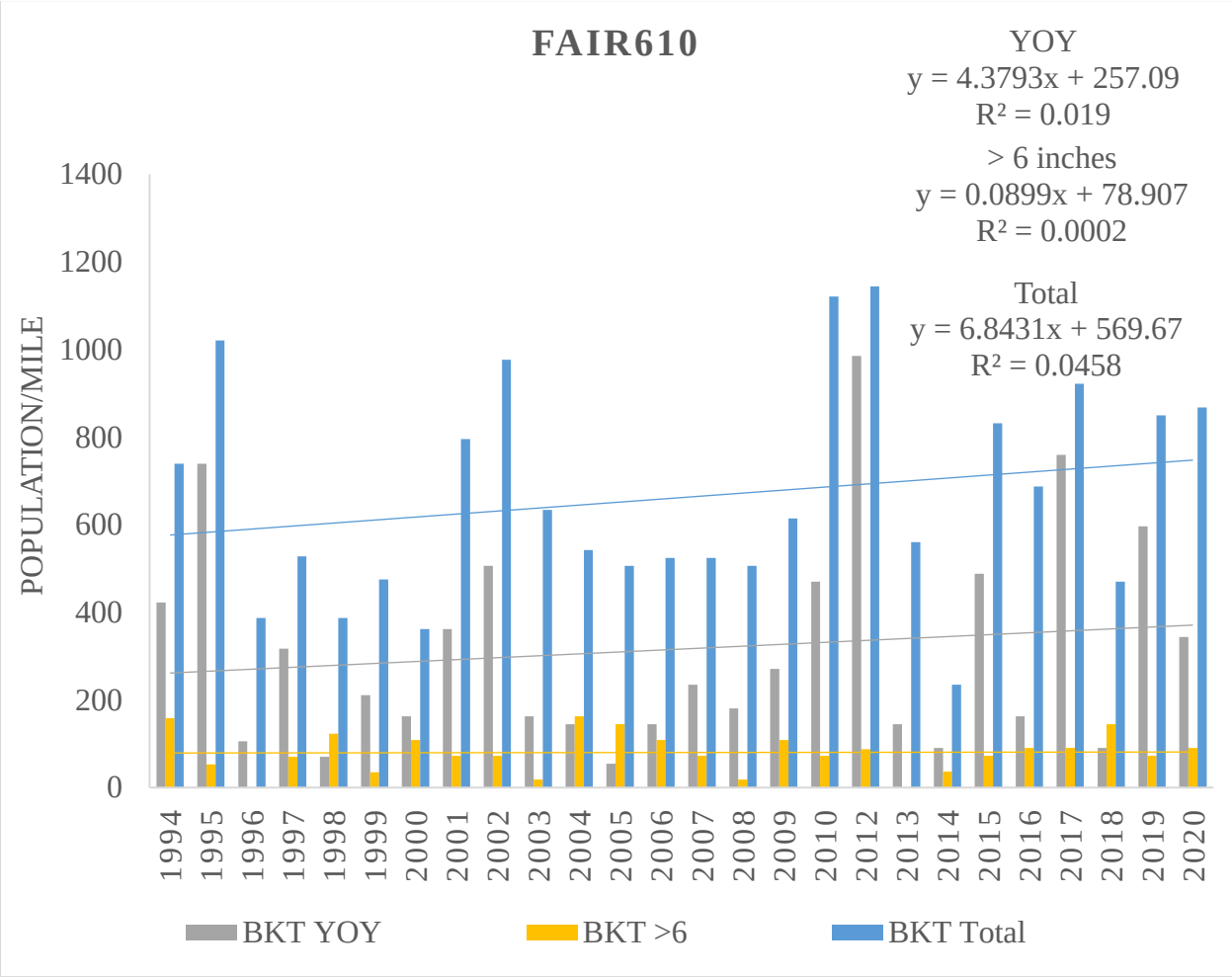


Figure 10. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

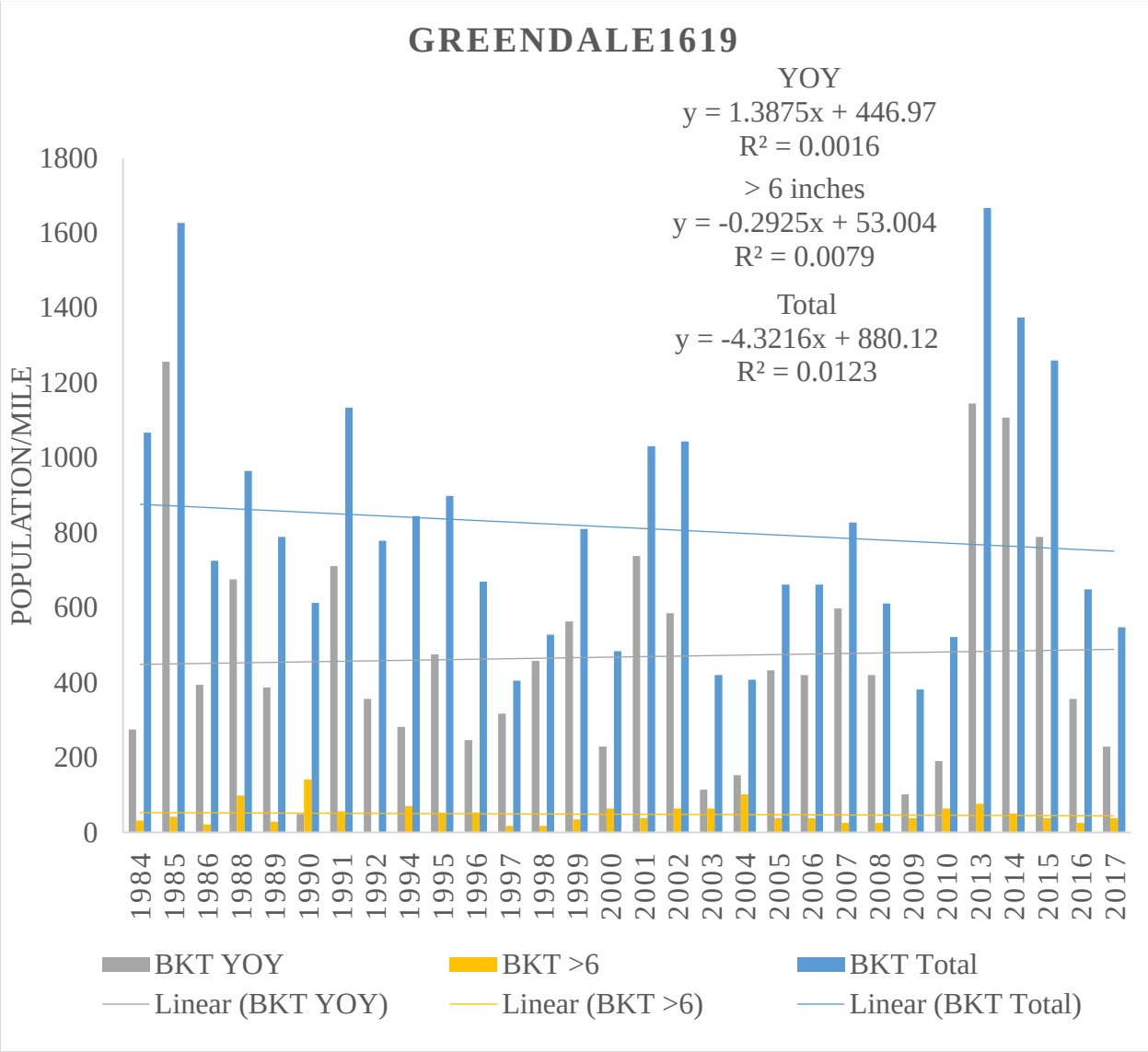


Figure 11. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

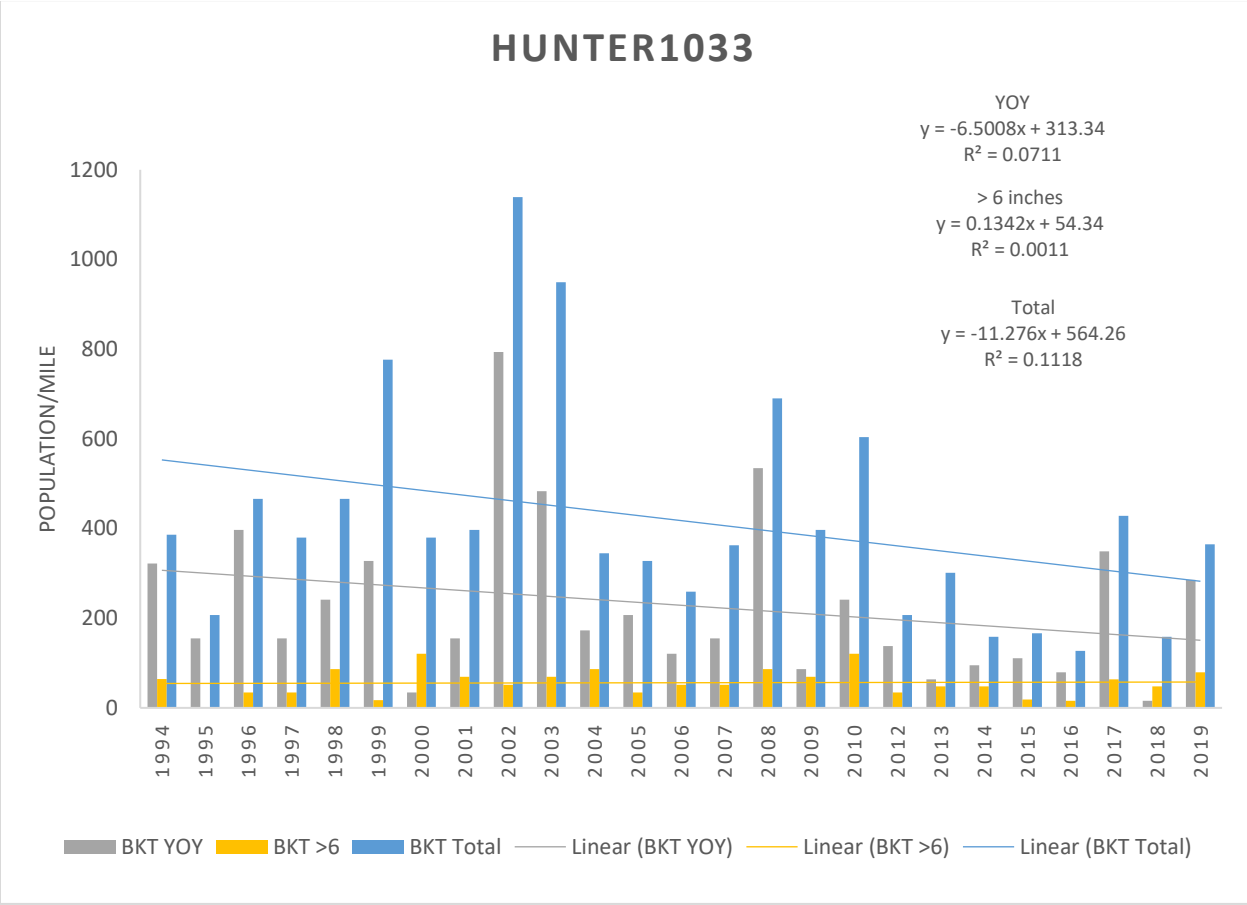


Figure 12. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

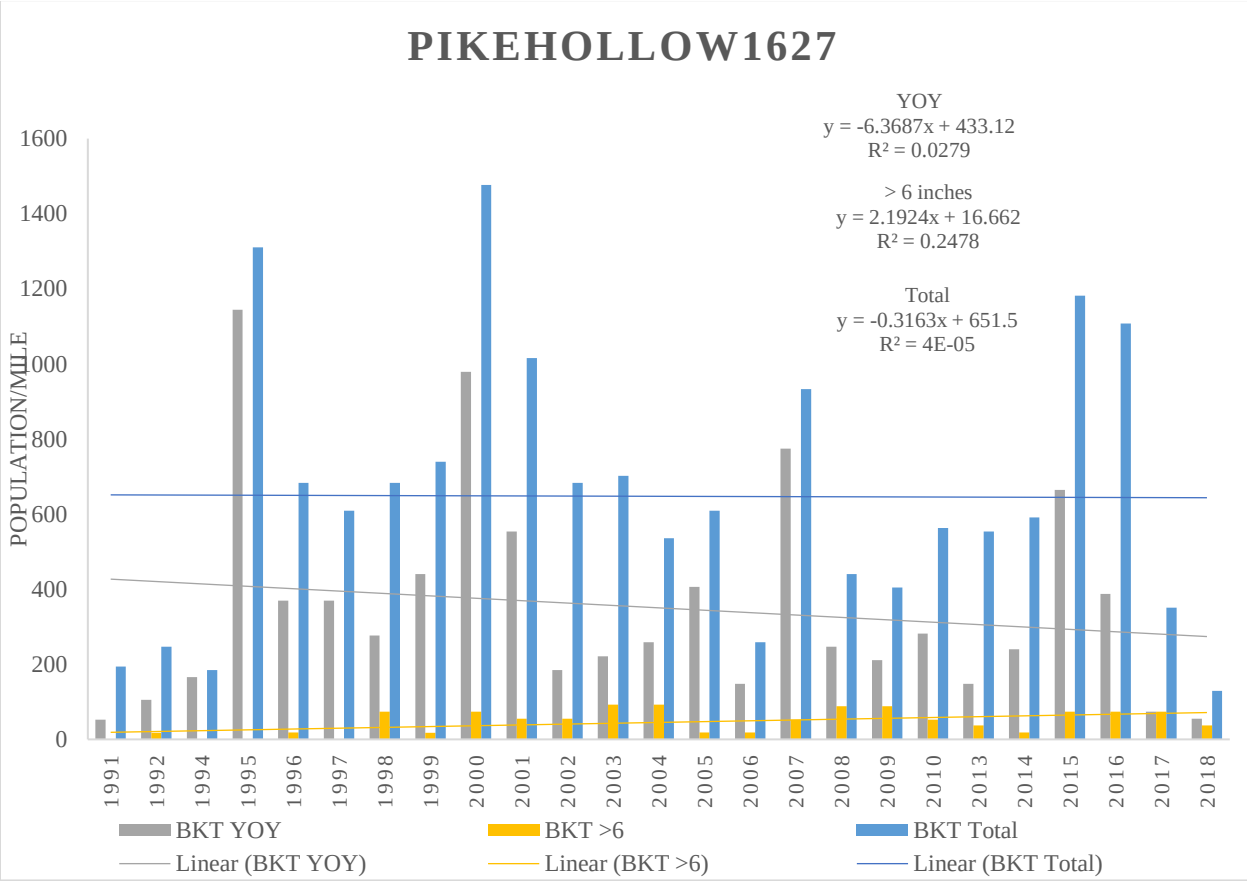


Figure 13. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

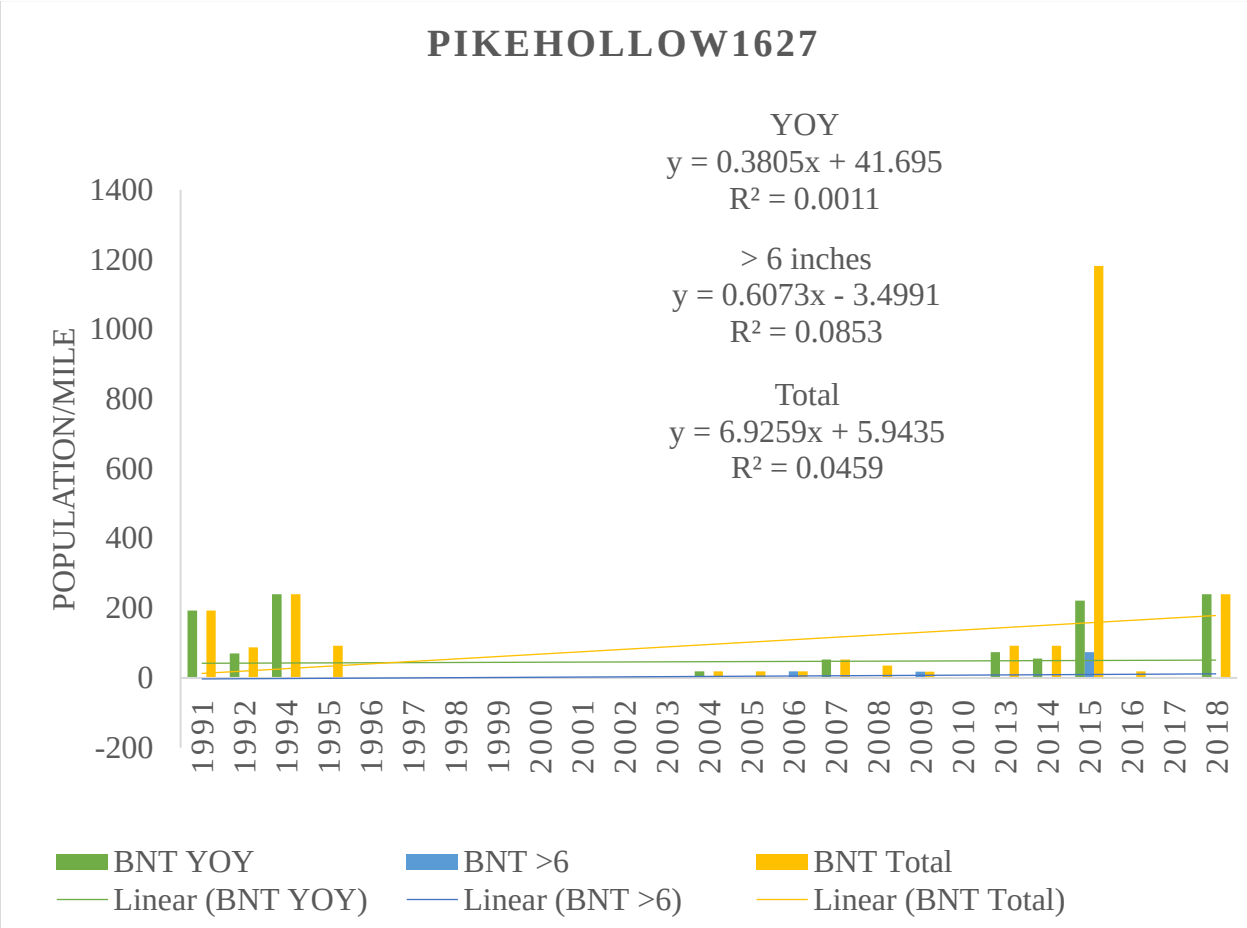


Figure 14. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

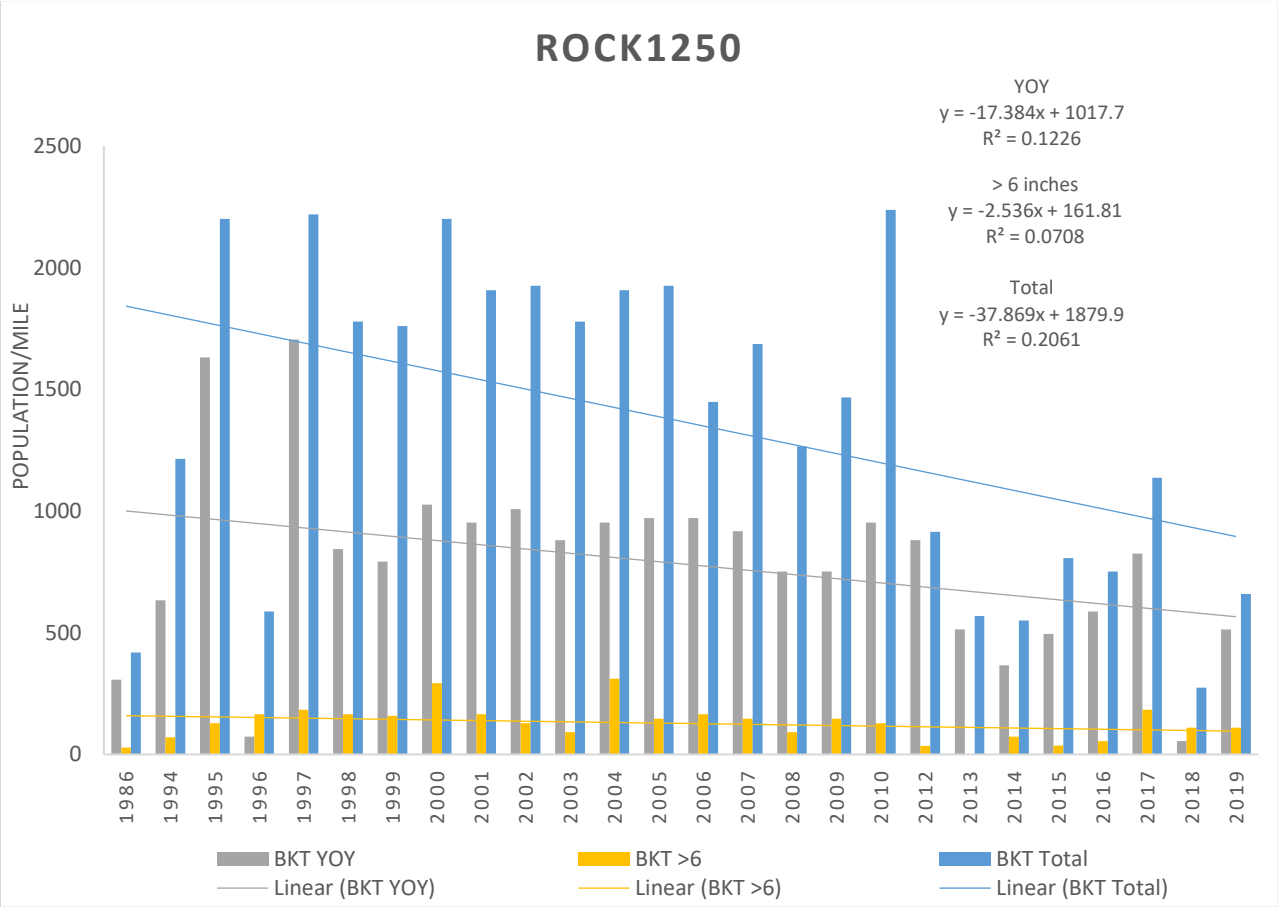


Figure 15. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

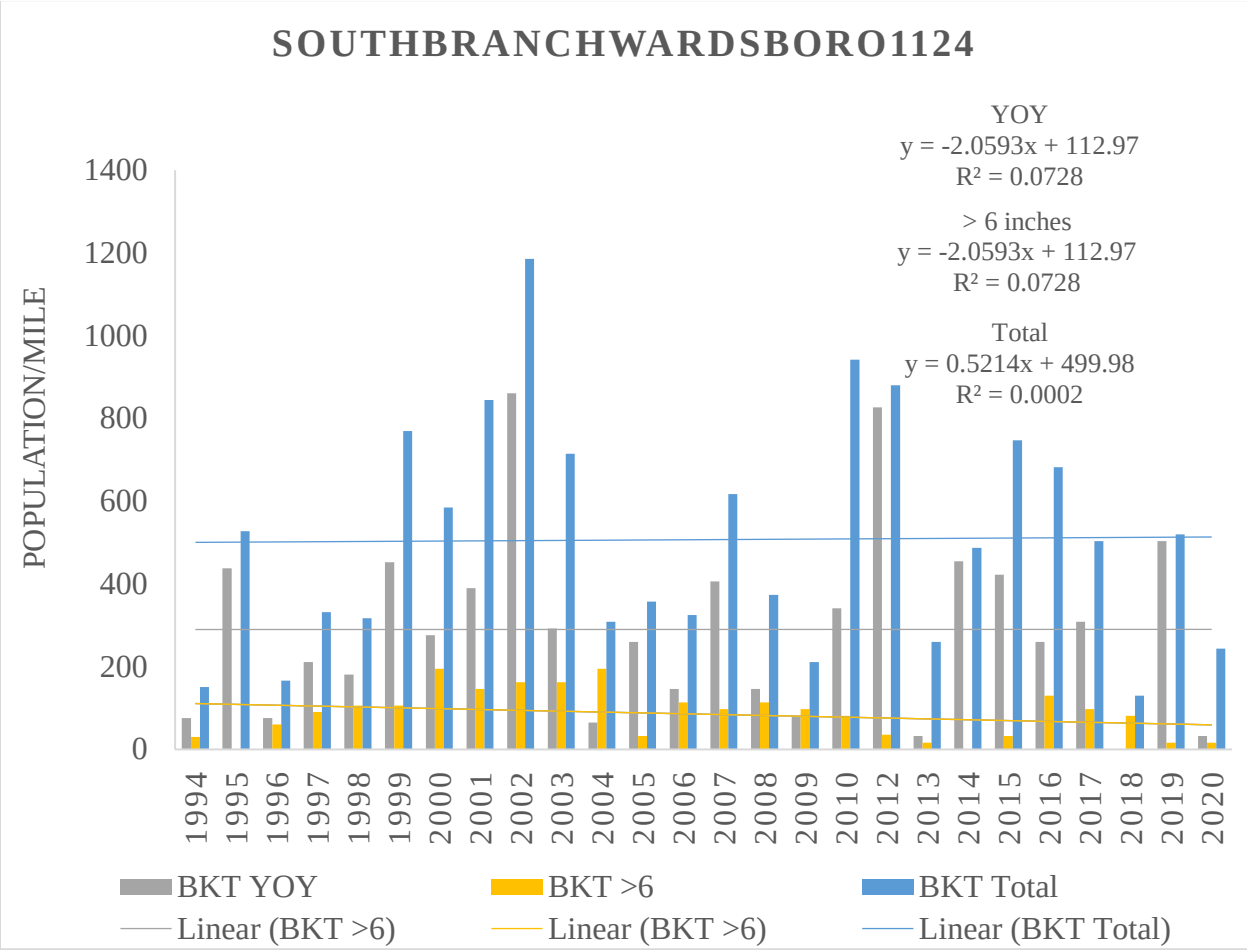


Figure 16. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

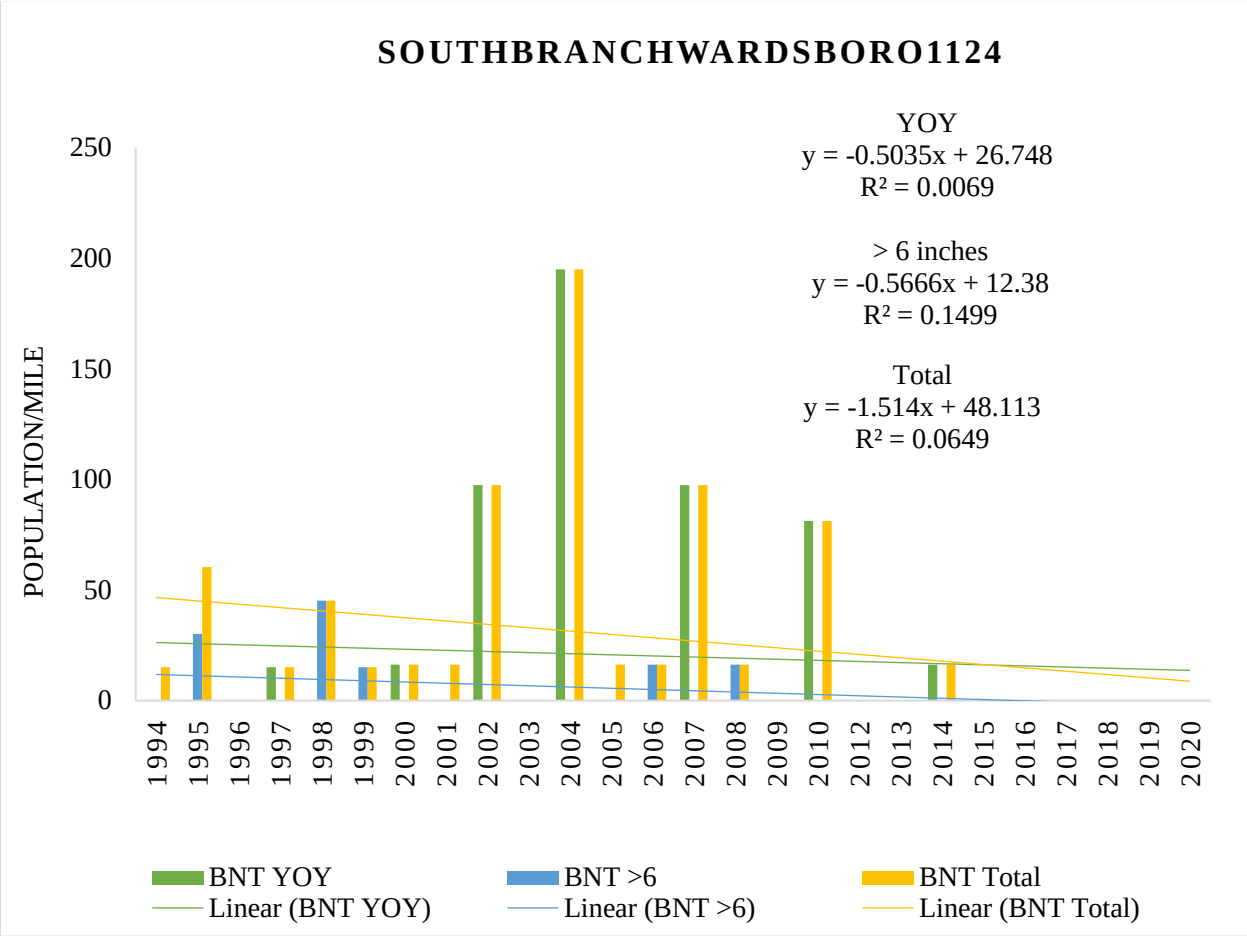


Figure 17. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

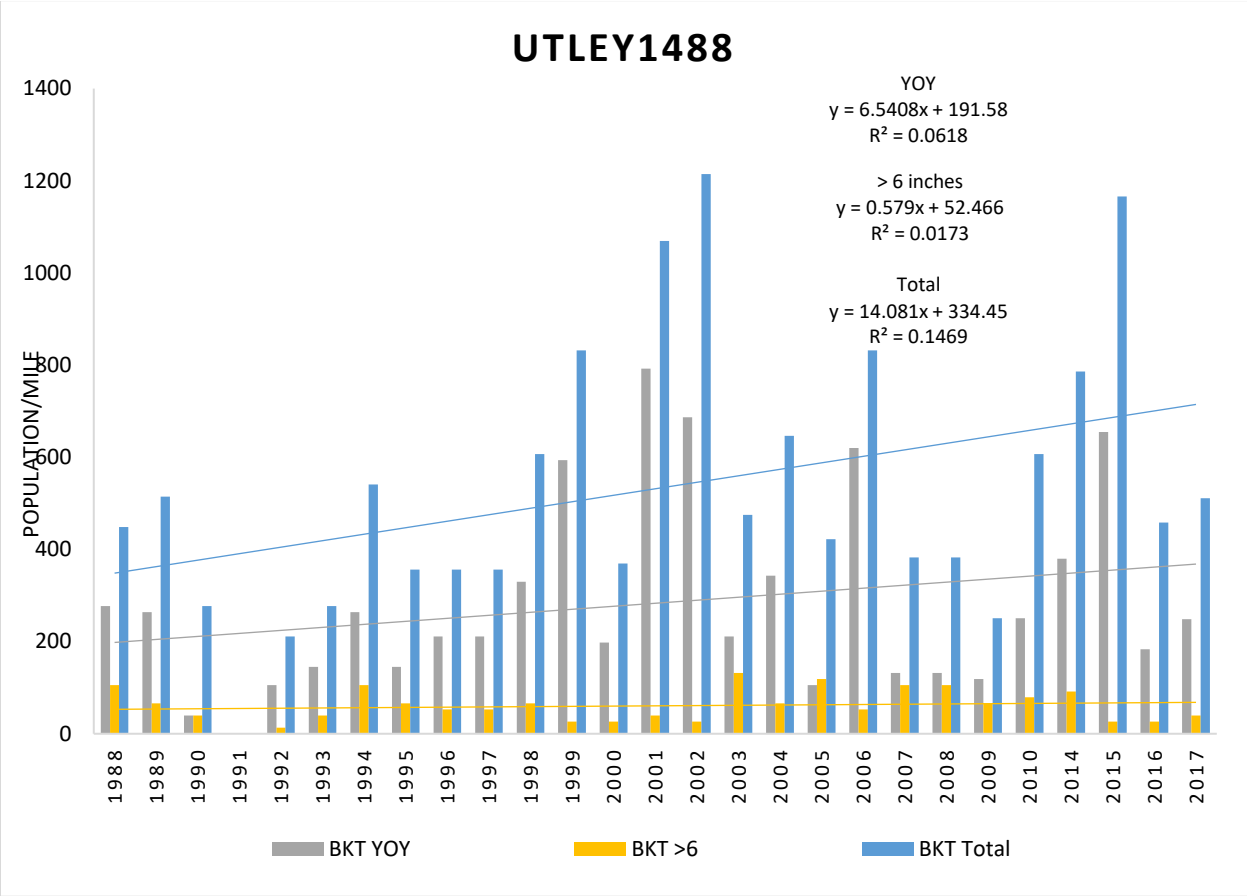


Figure 18. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

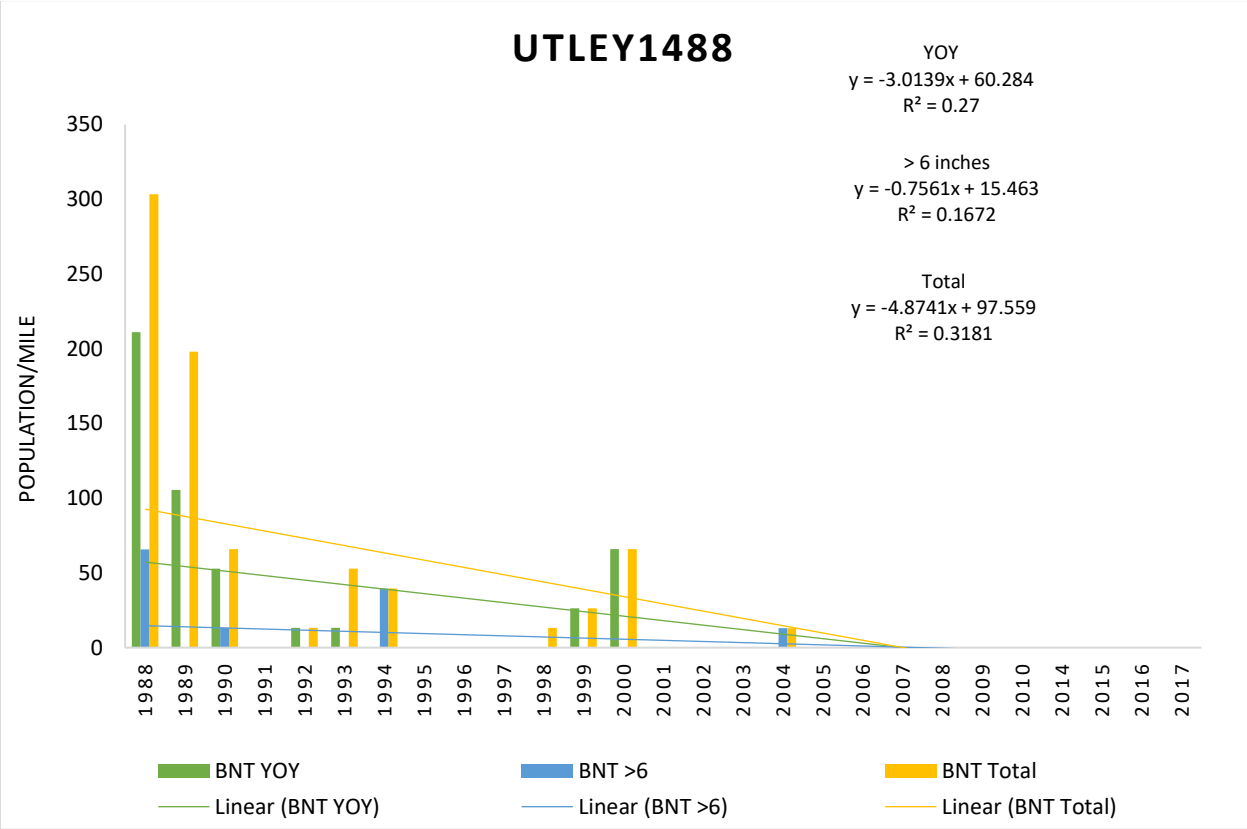


Figure 19. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

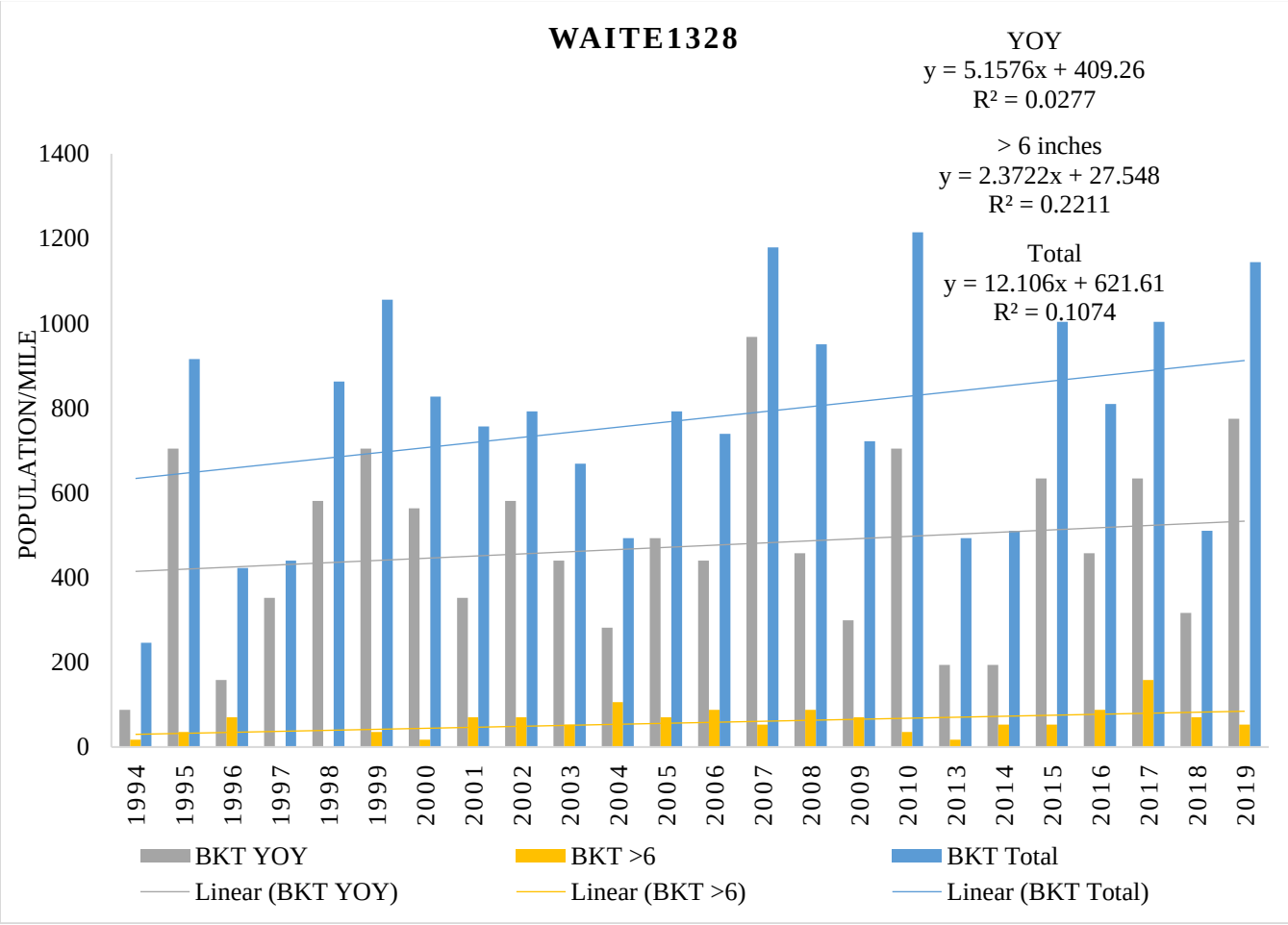


Figure 20. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

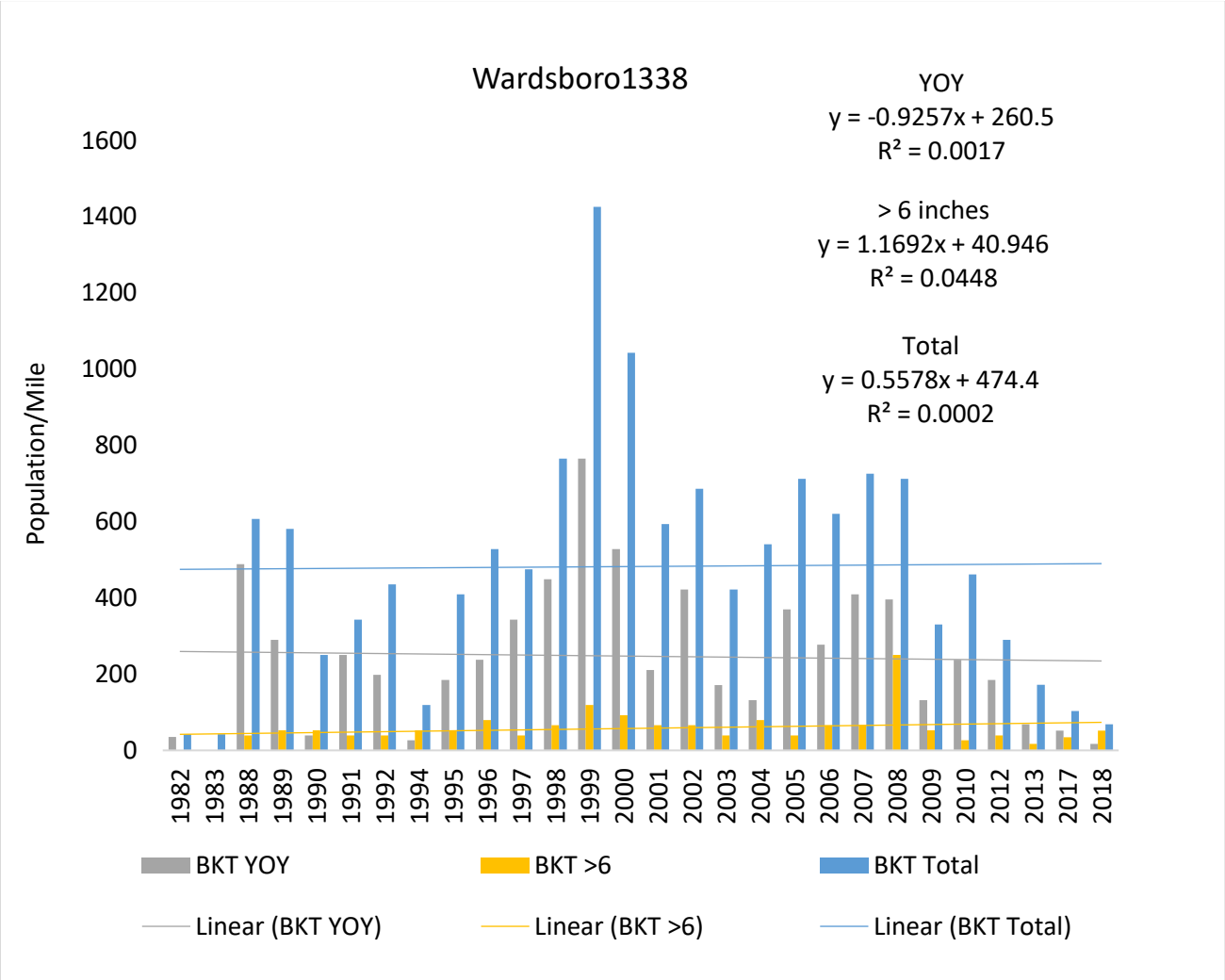


Figure 21. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

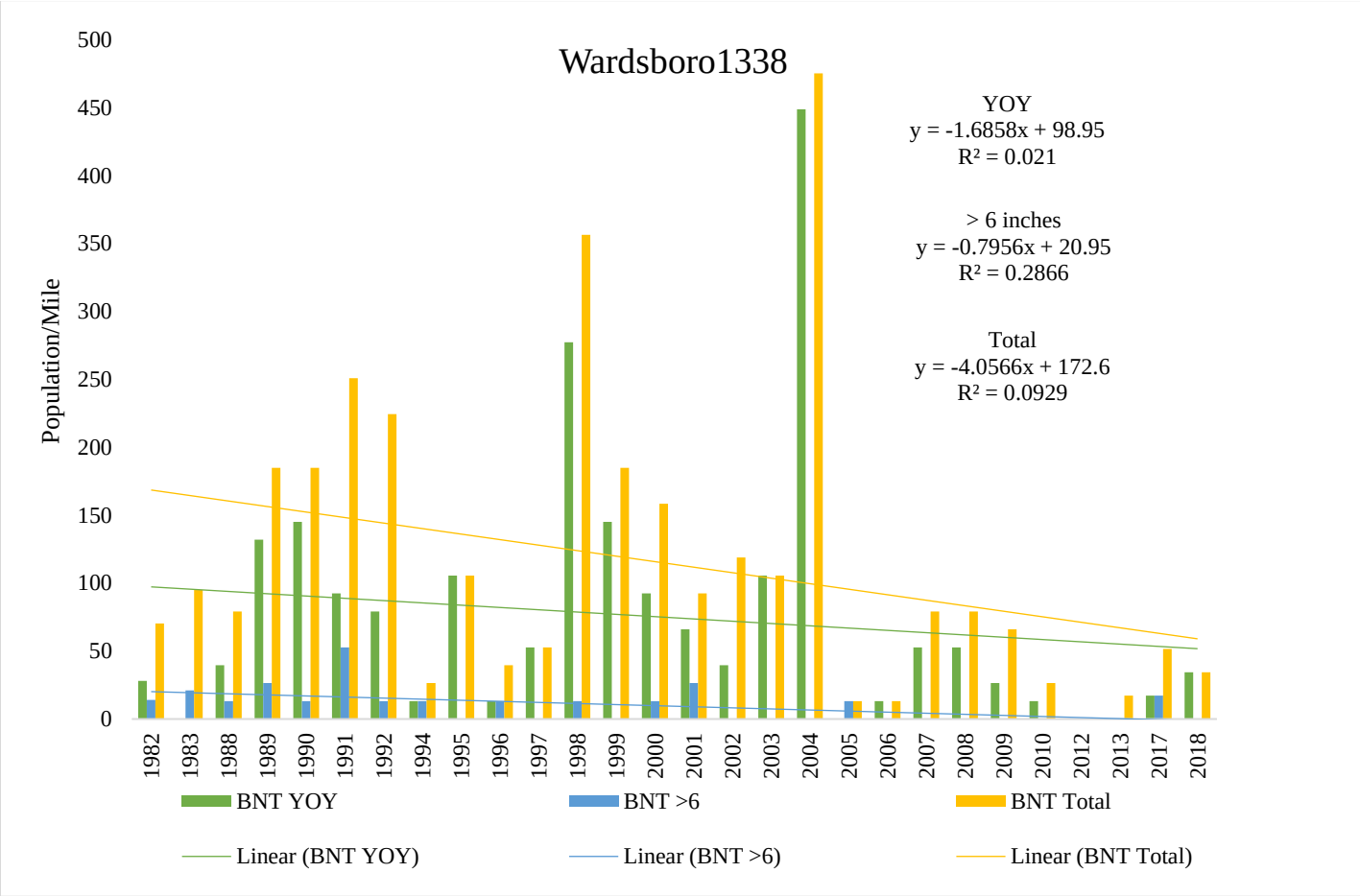


Figure 22. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

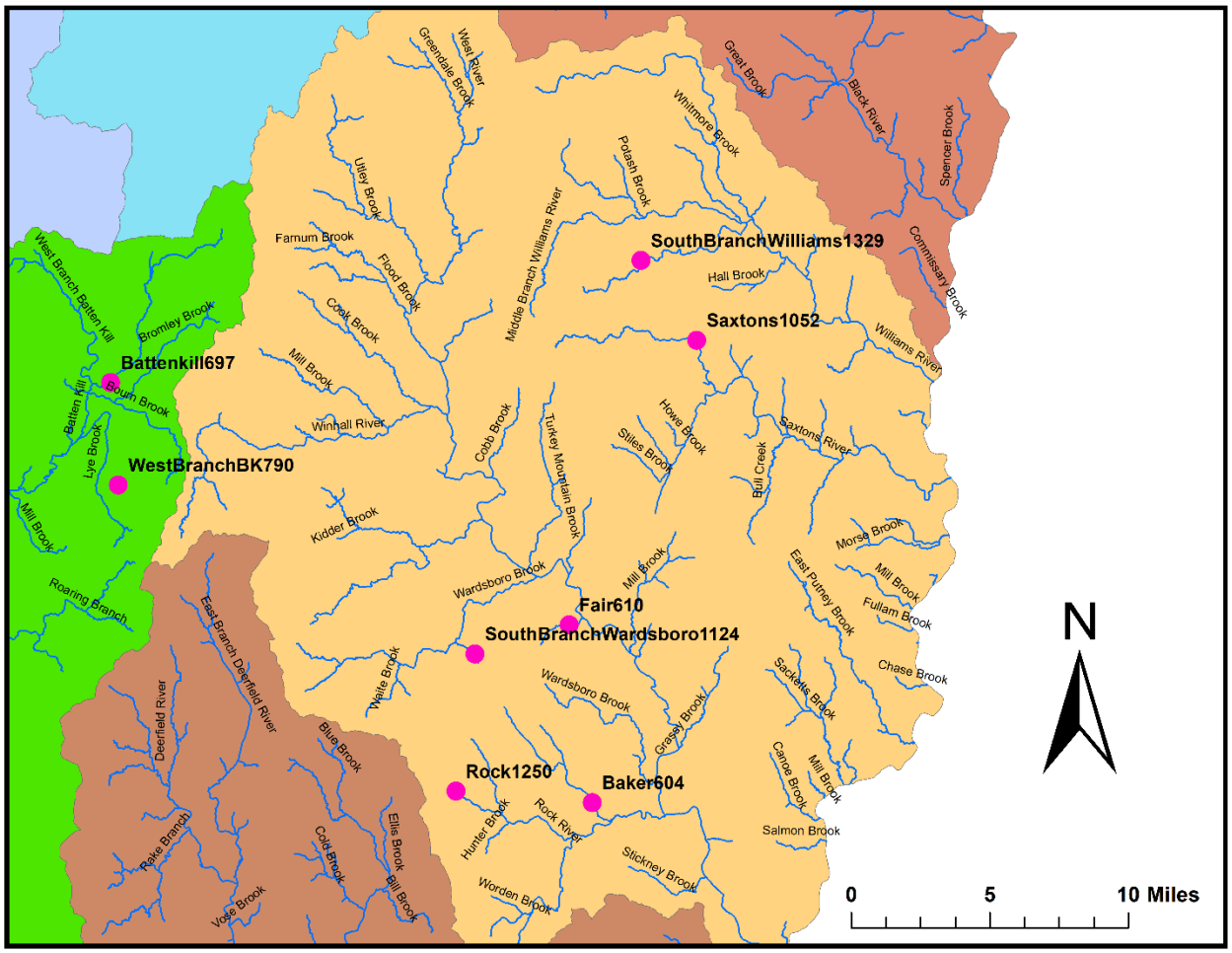


Figure 23. Long term temperature and trout monitoring sites.

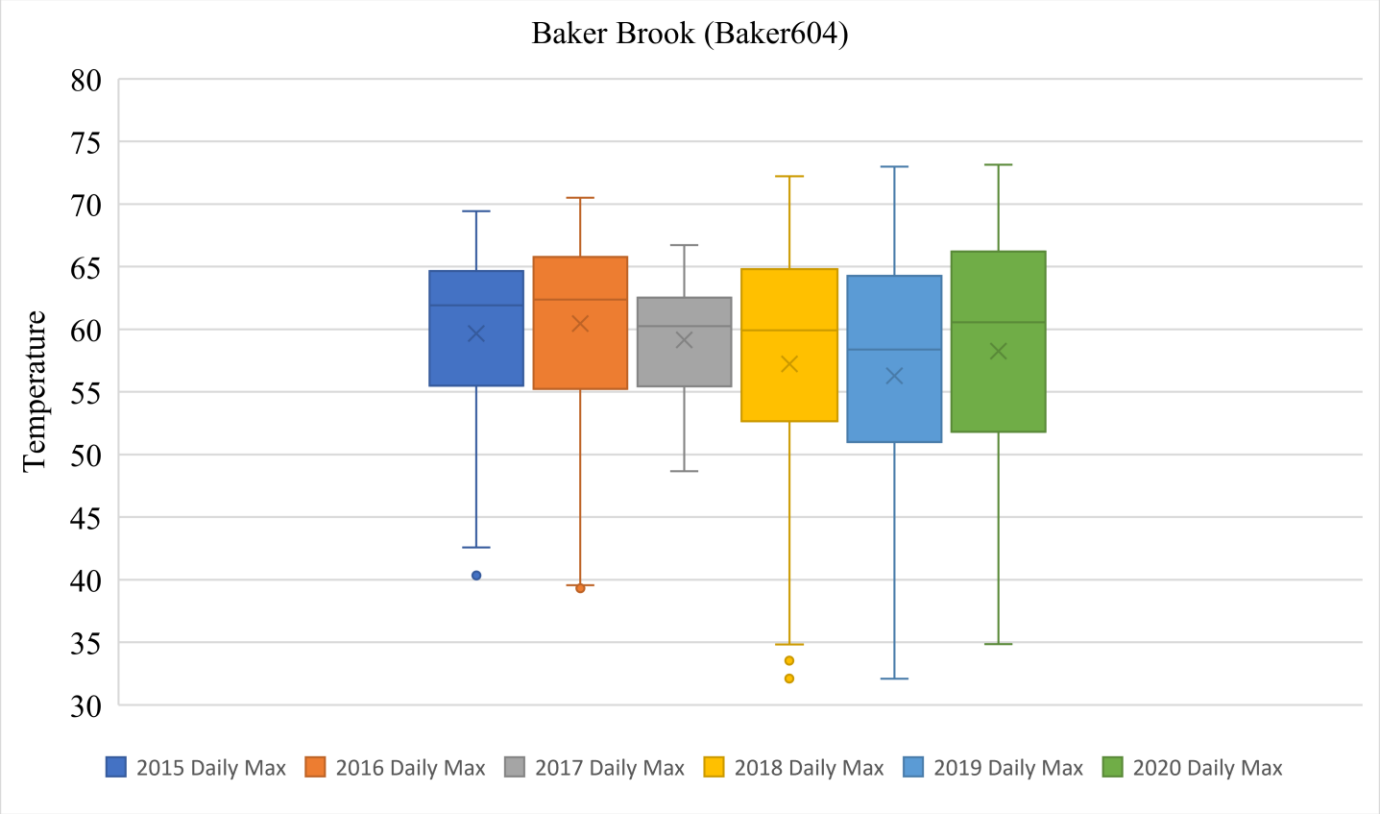


Figure 24. Daily maximum stream temperatures recorded 2015-2020.

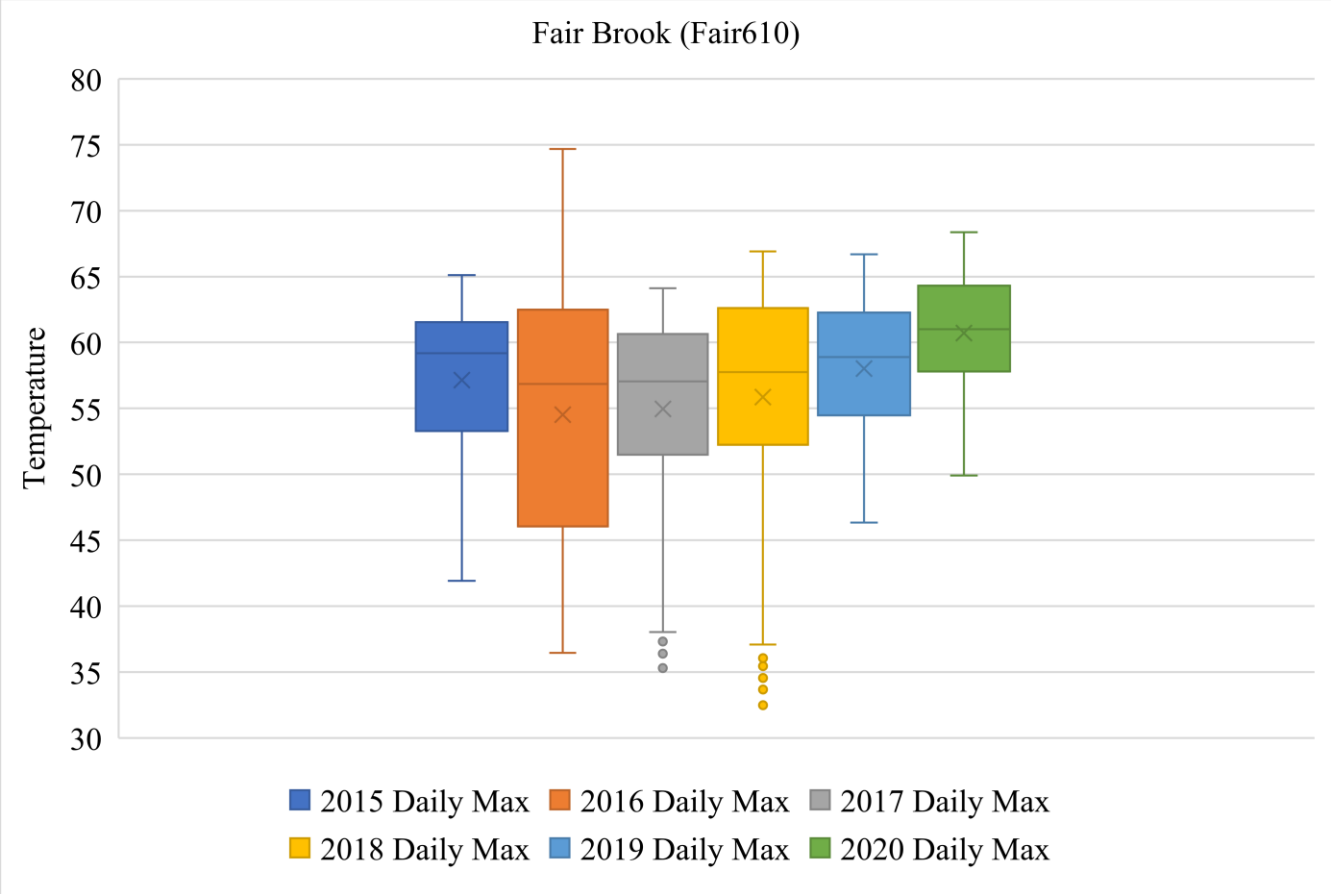


Figure 25. Daily maximum stream temperatures recorded 2015-2020.

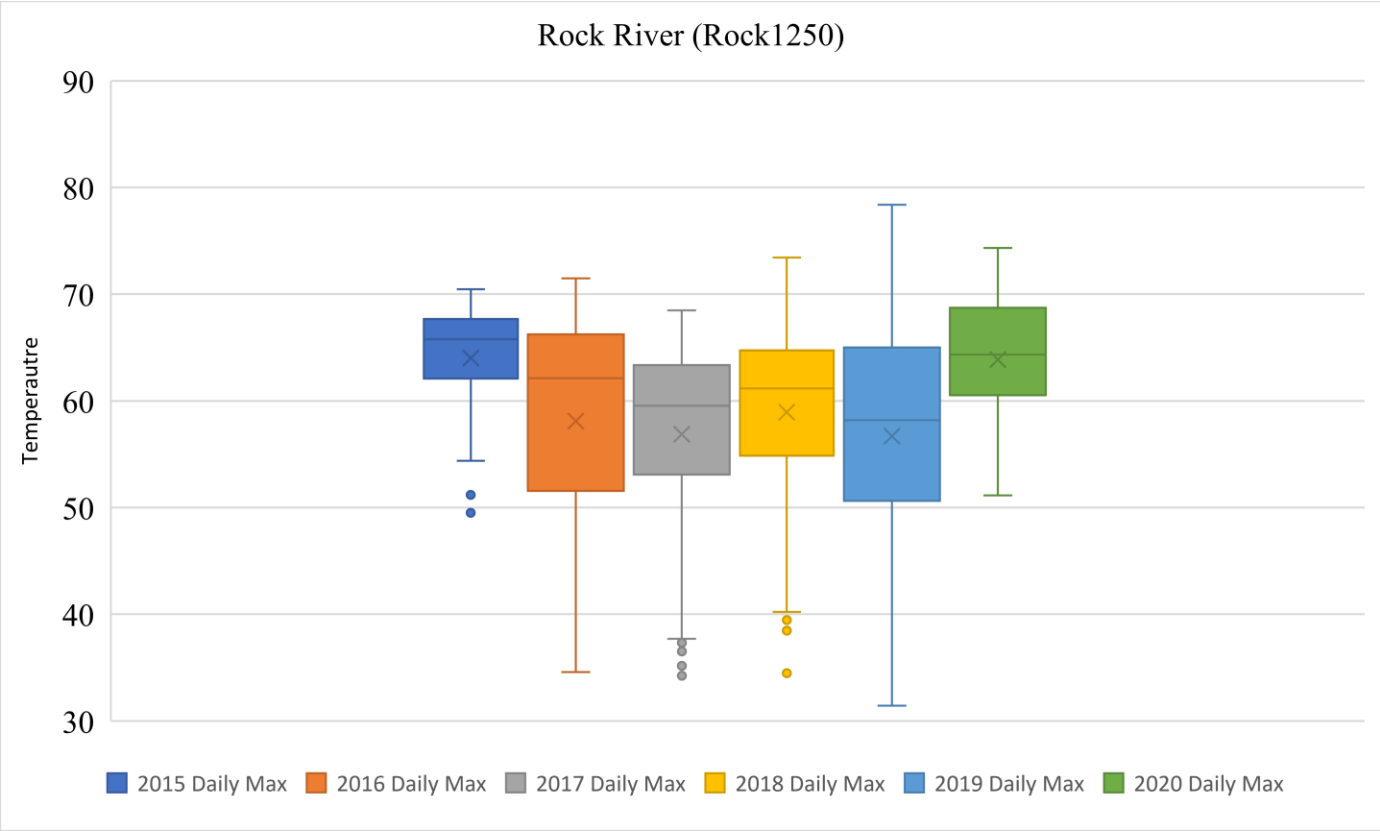


Figure 26. Daily maximum stream temperatures recorded 2015-2020.

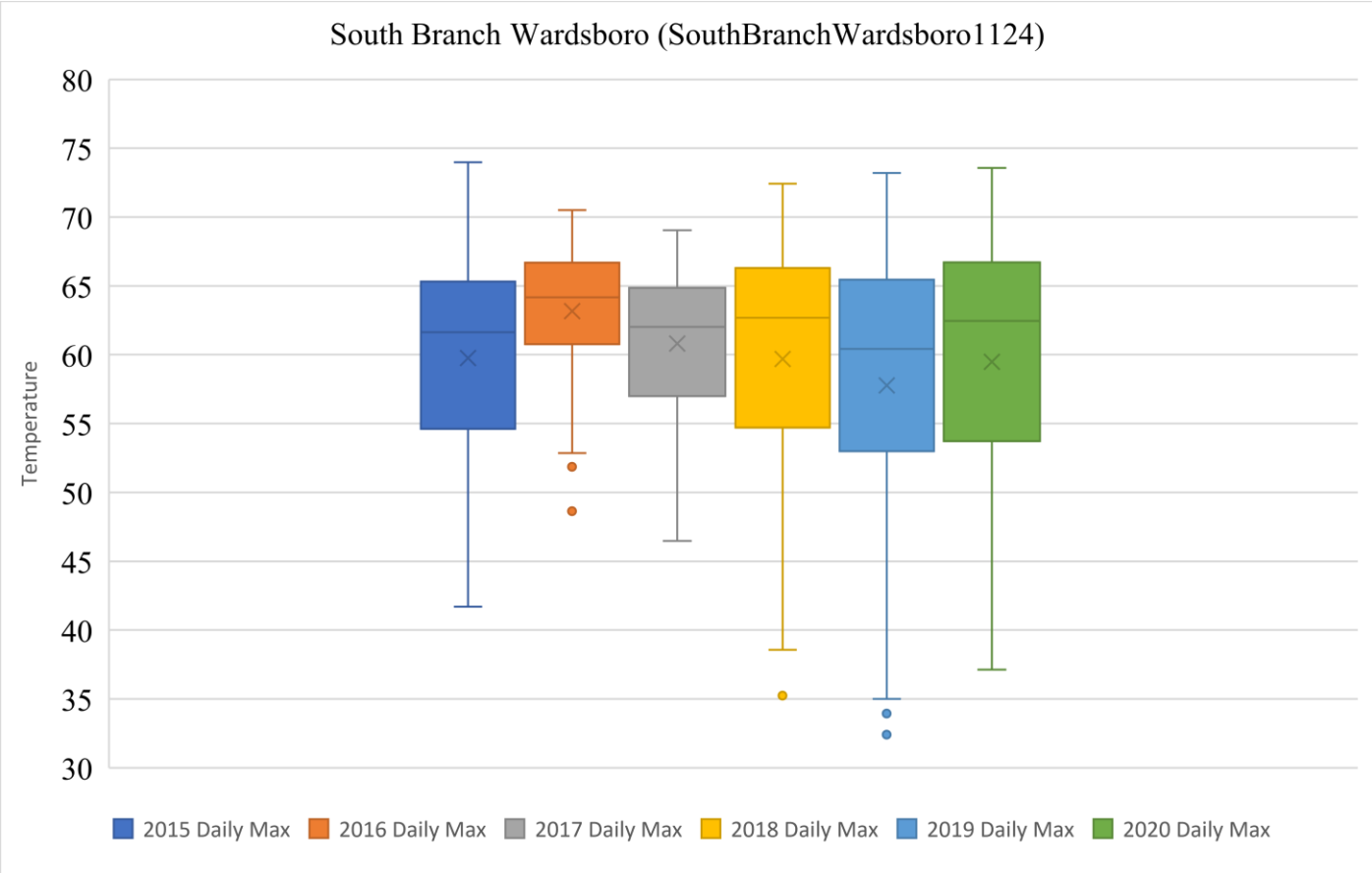


Figure 27. Daily maximum stream temperatures recorded 2015-2020.

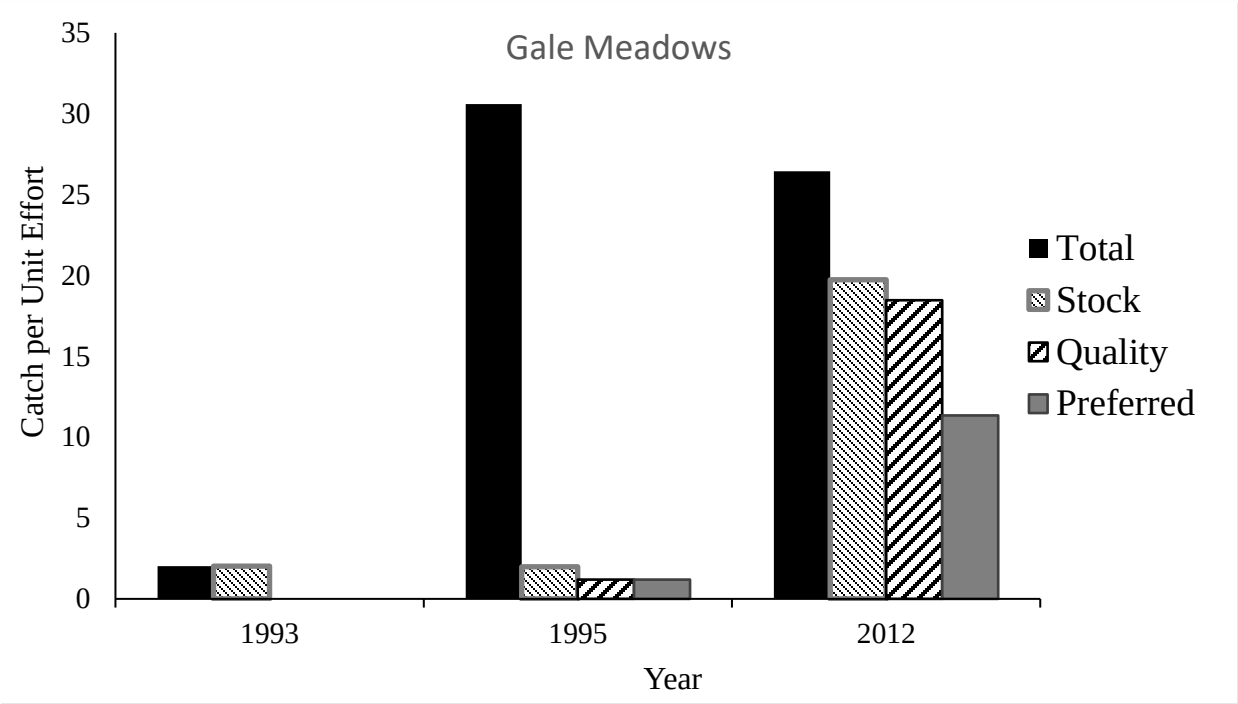


Figure 28. Gale Meadows Bass Electrofishing catch rates by size class.

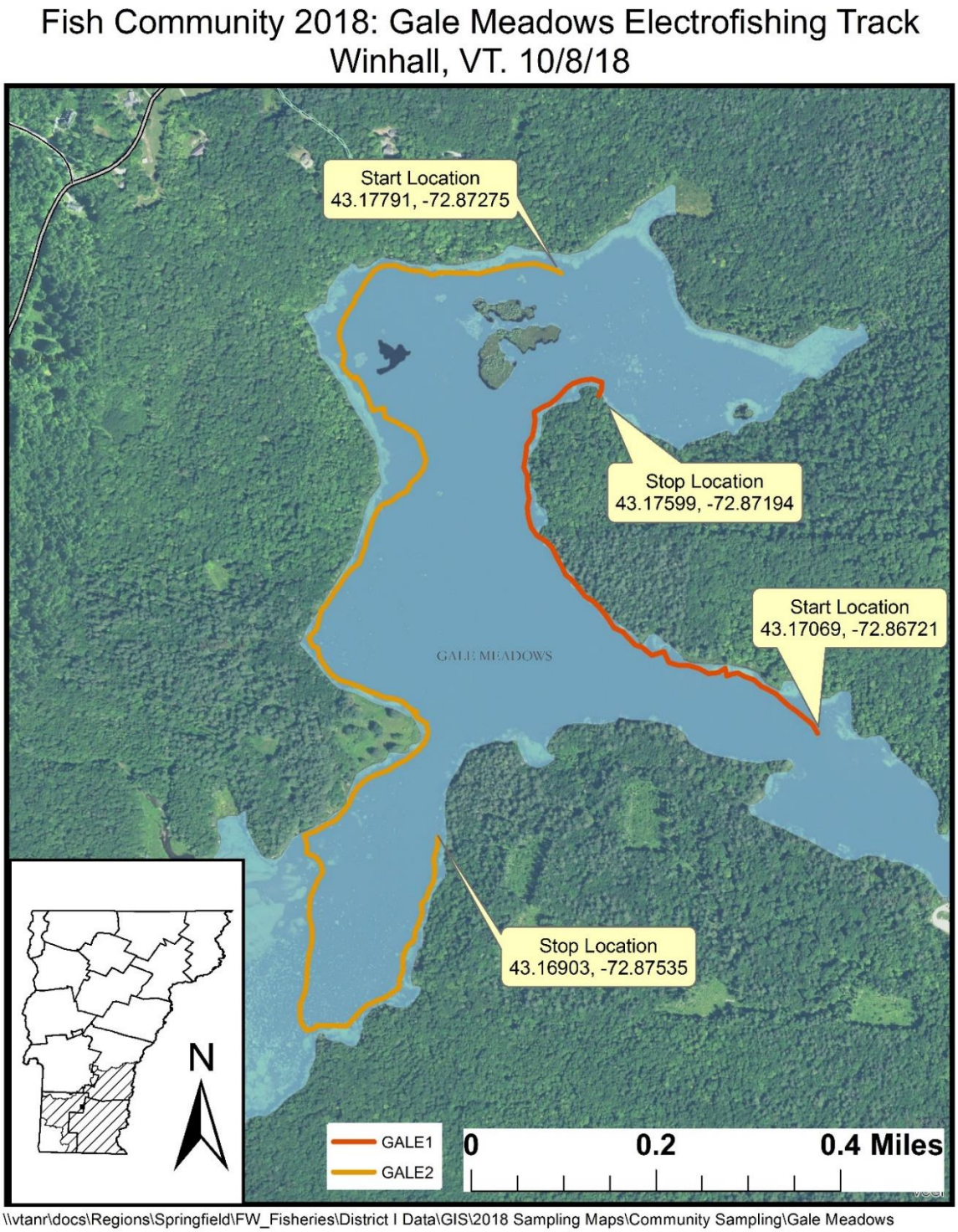


Figure 29. Map of 2018 Fish Community Sampling in Gale Meadows.

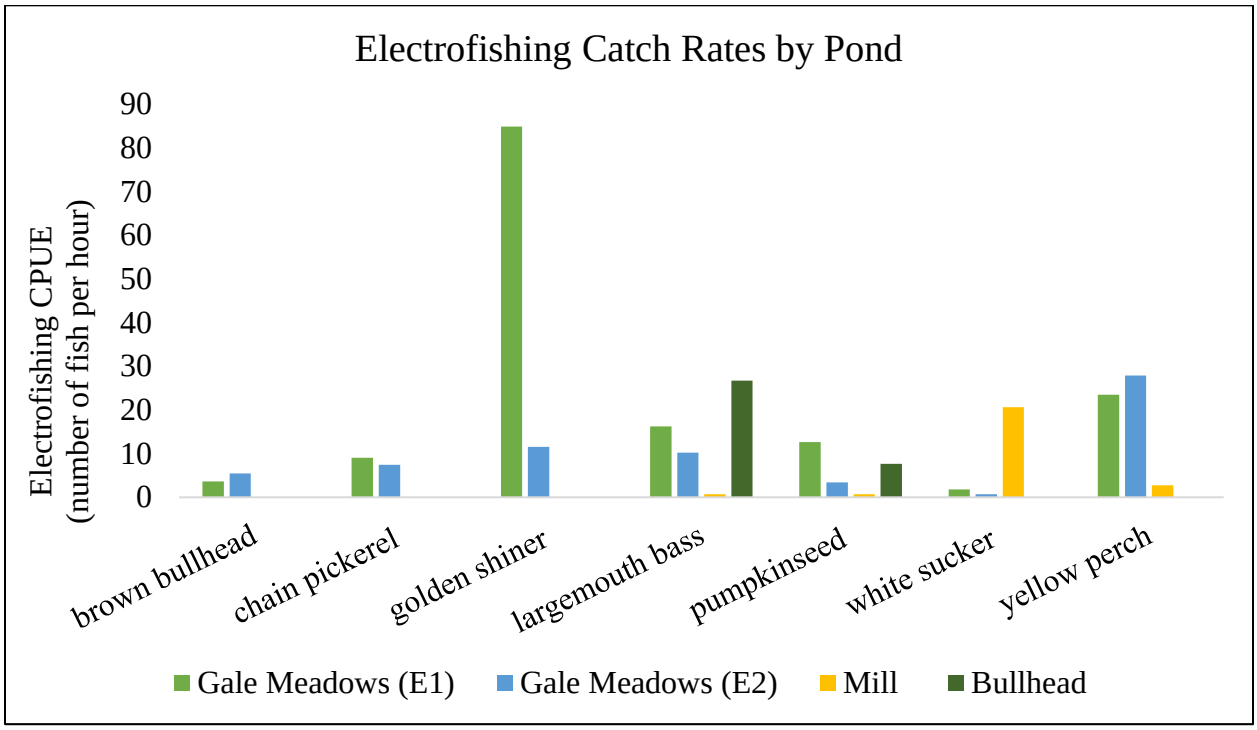


Figure 30. Fish community sampling in Gale Meadows 2018.

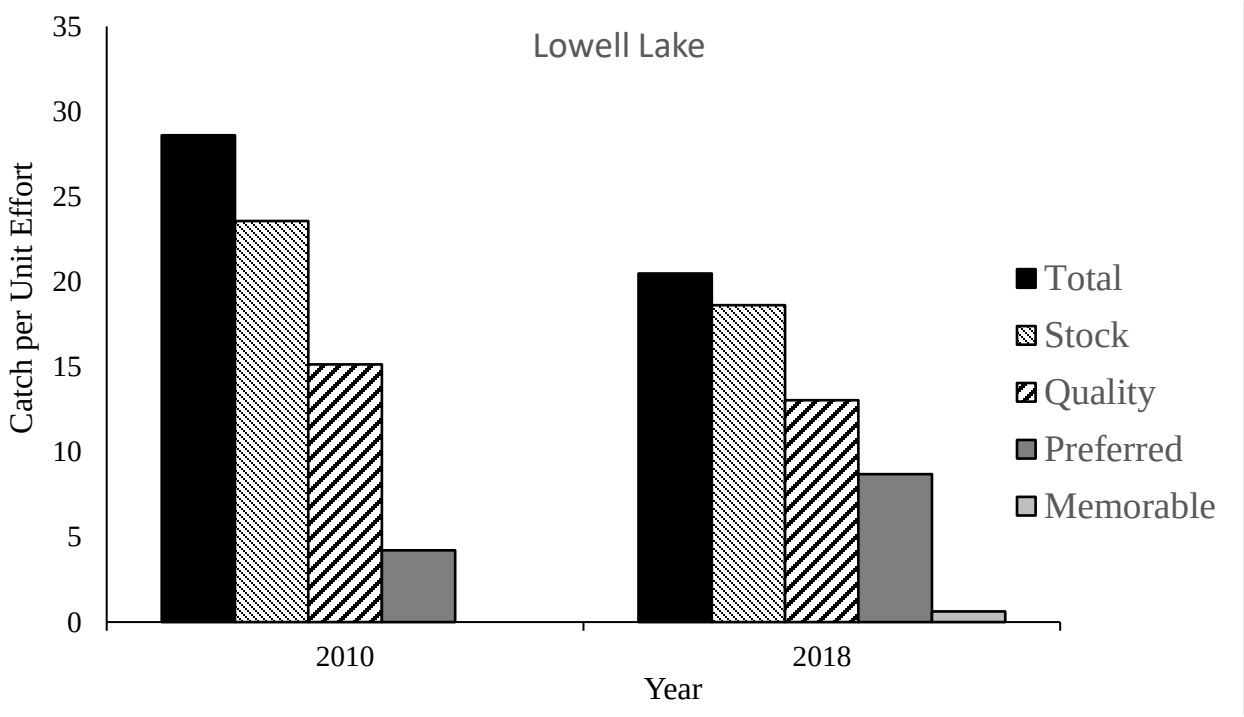


Figure 31. Lowell Lake Bass Electrofishing catch rates by size class.

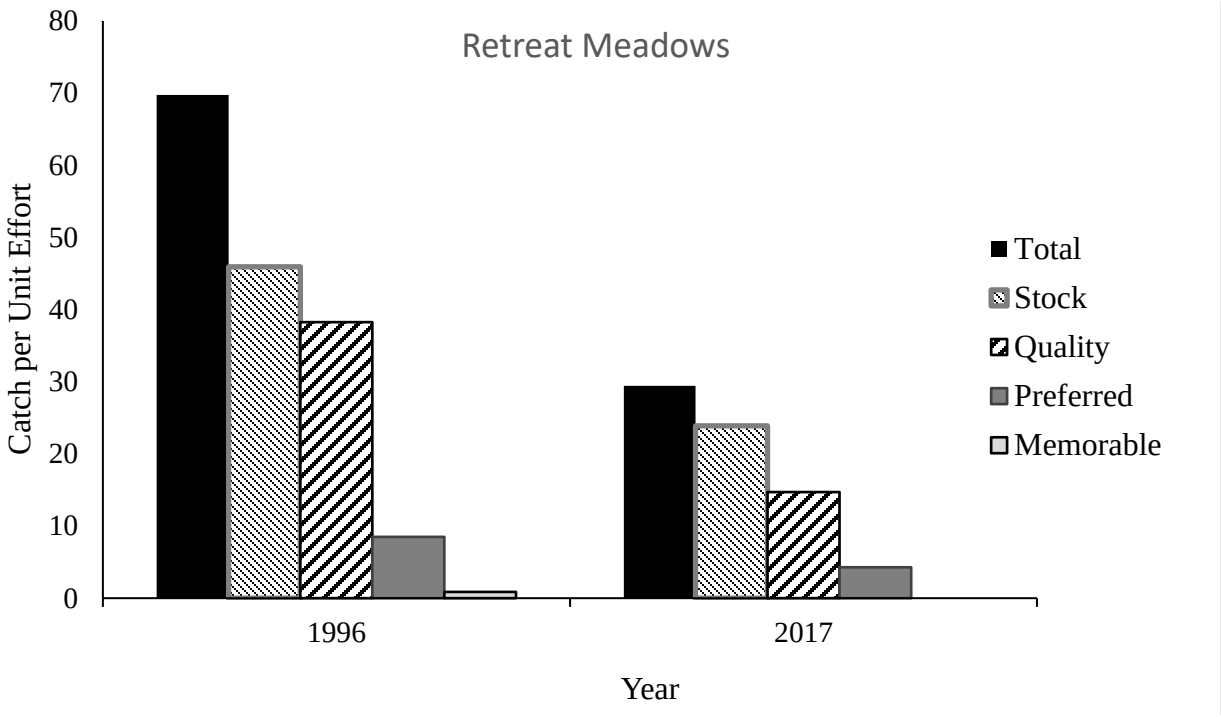


Figure 32. Lowell Lake Bass Electrofishing catch rates by size class.

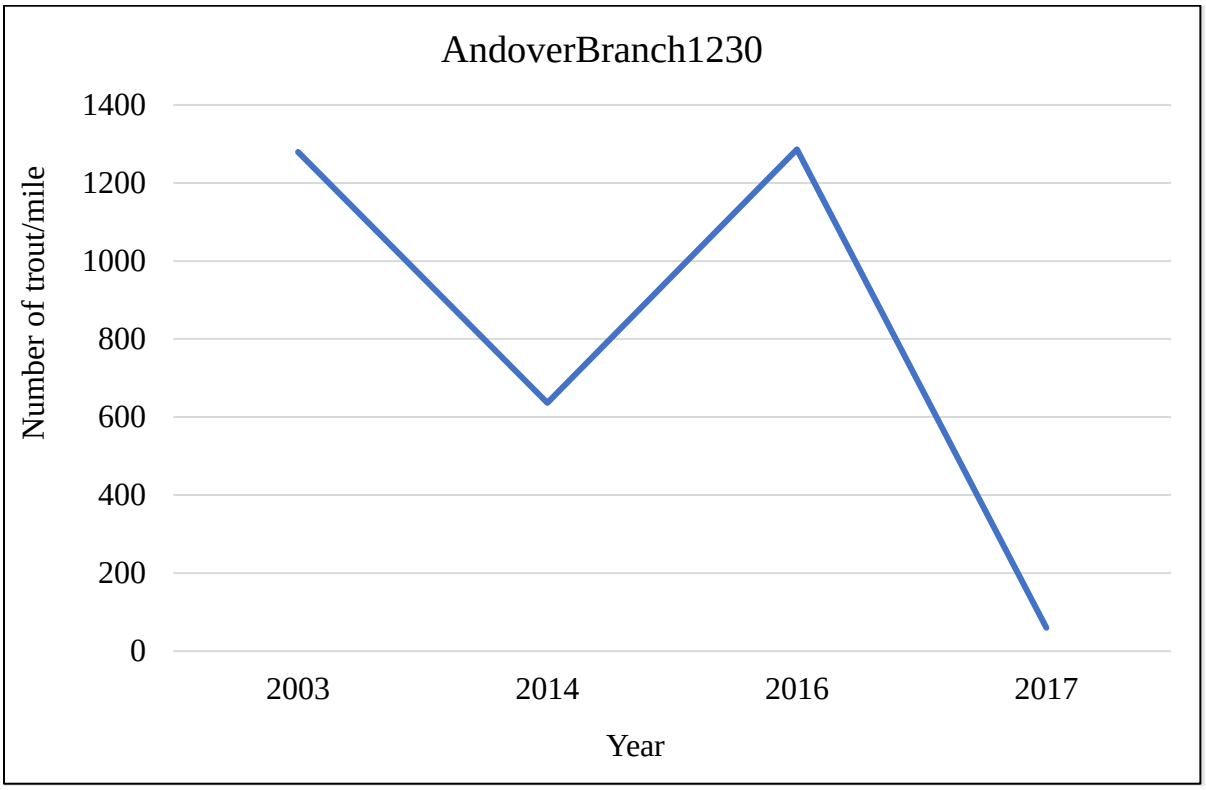


Figure 33. Brook Trout population estimates (All size classes combined).

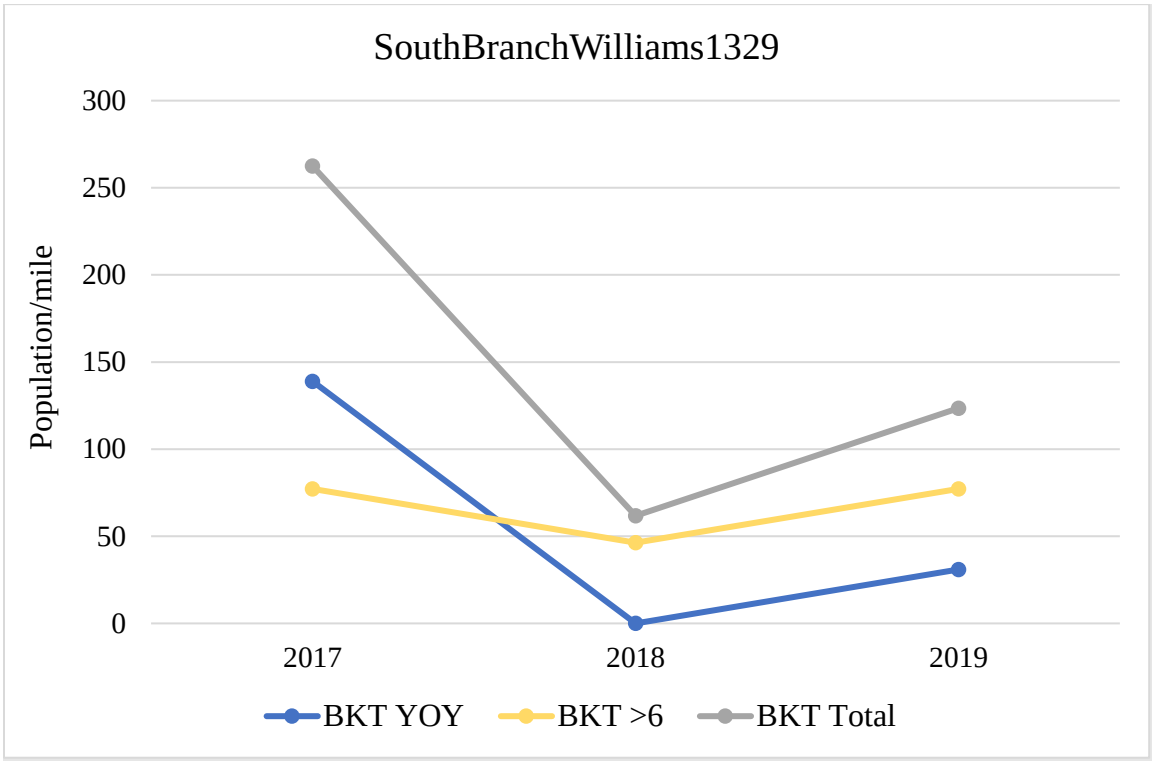


Figure 34. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

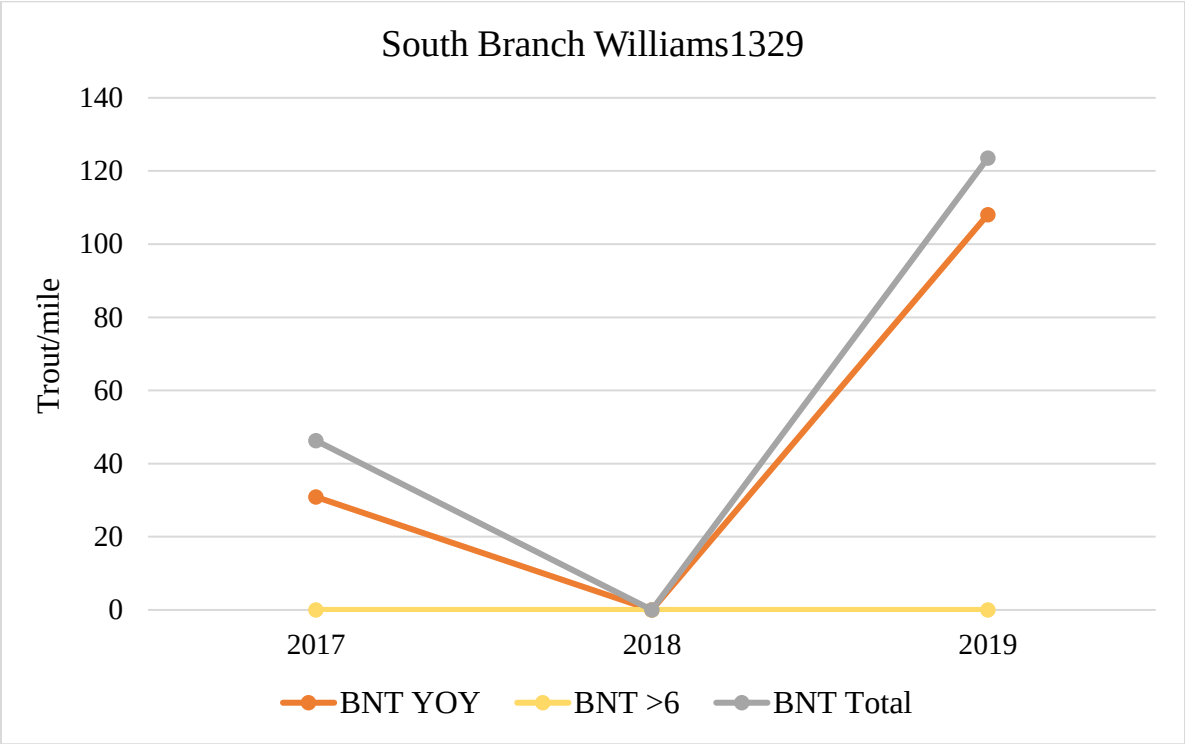


Figure 35. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

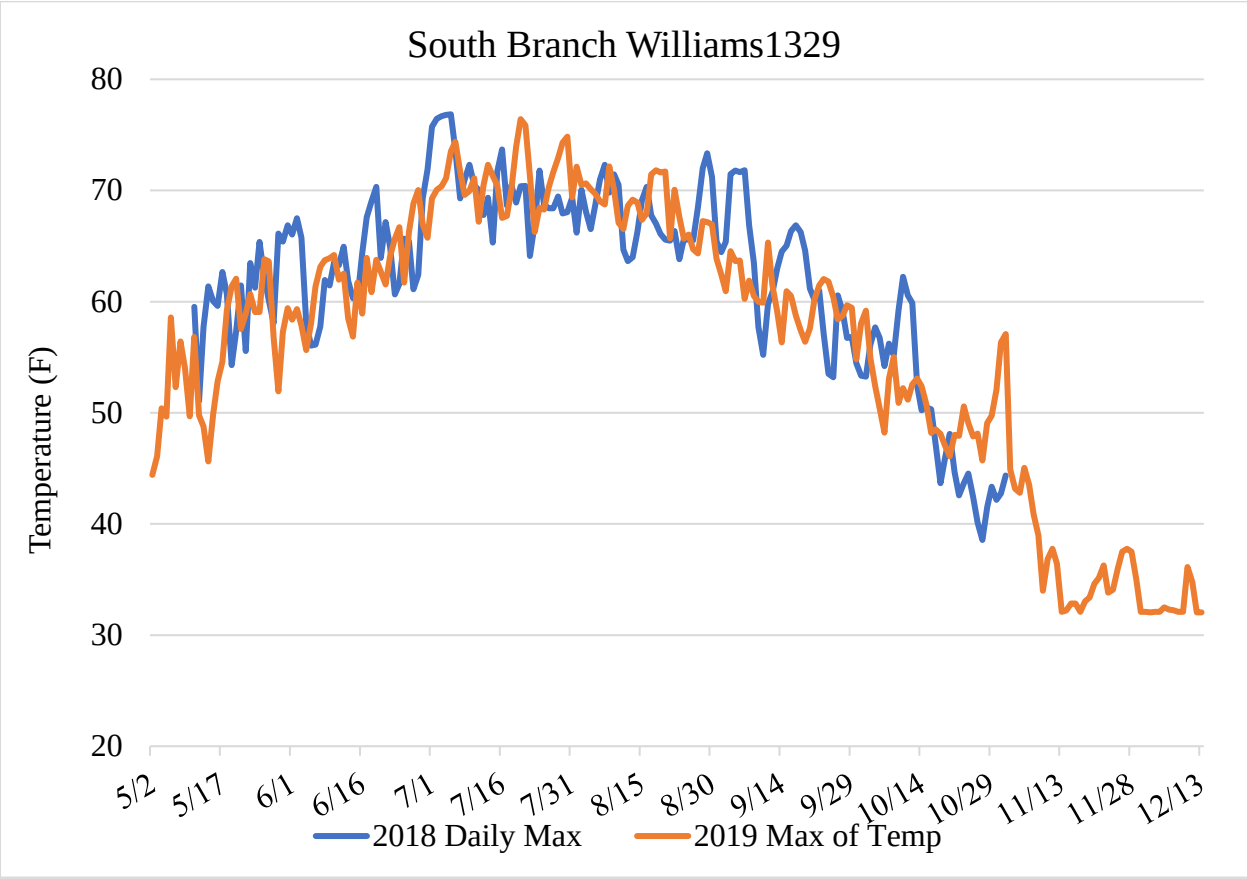


Figure 36. Daily maximum stream temperatures recorded 2018-2019.

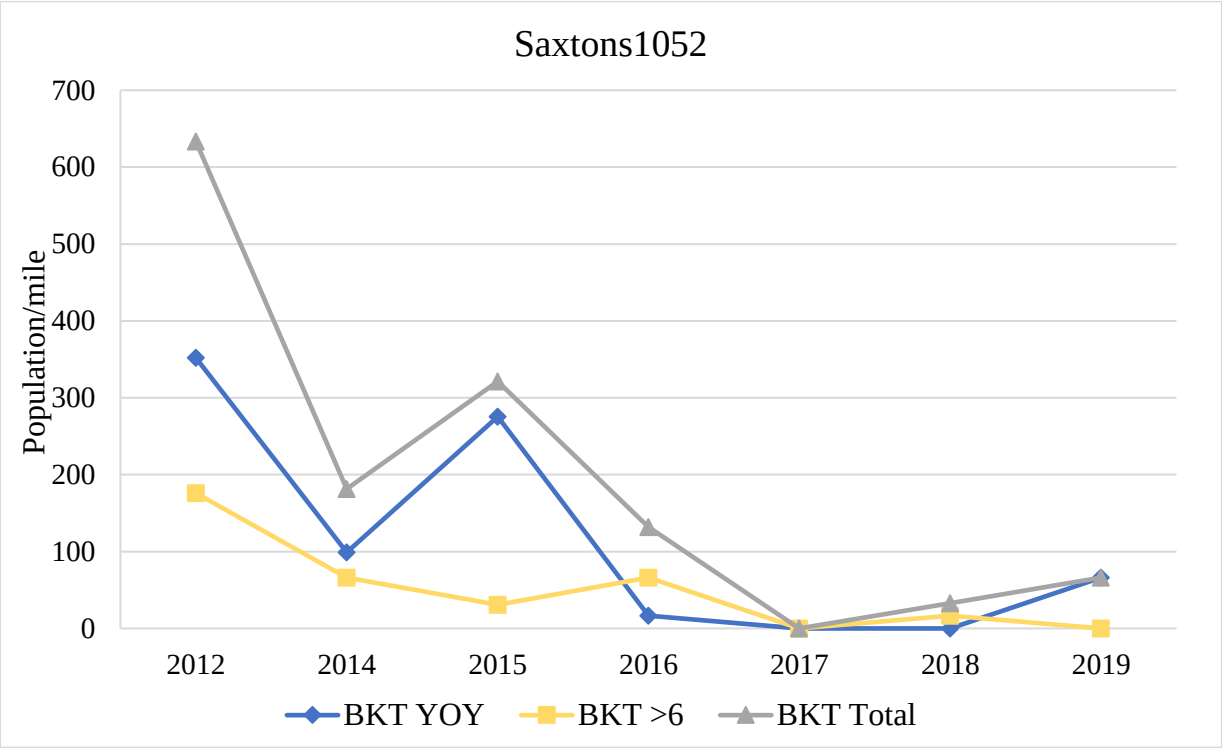


Figure 37. Brook Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

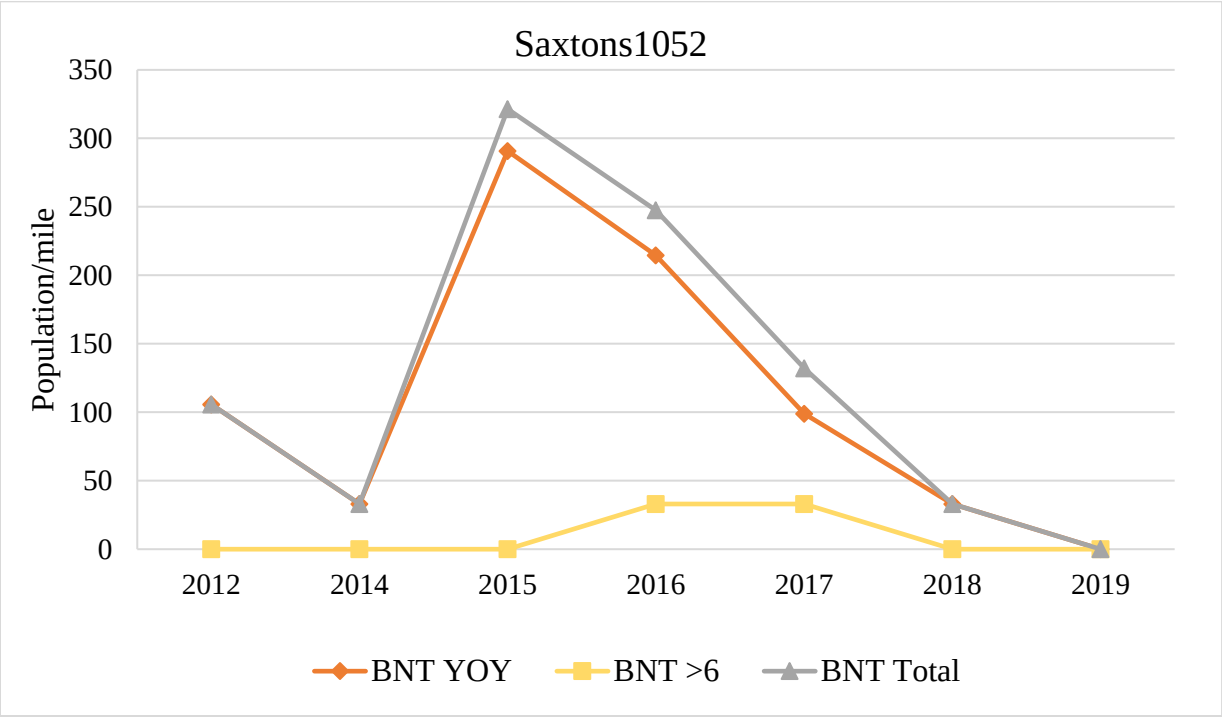


Figure 38. Brown Trout population estimates by size class (Young of Year, Greater than 6 inches, All size classes combined) at year at long-term monitoring sites.

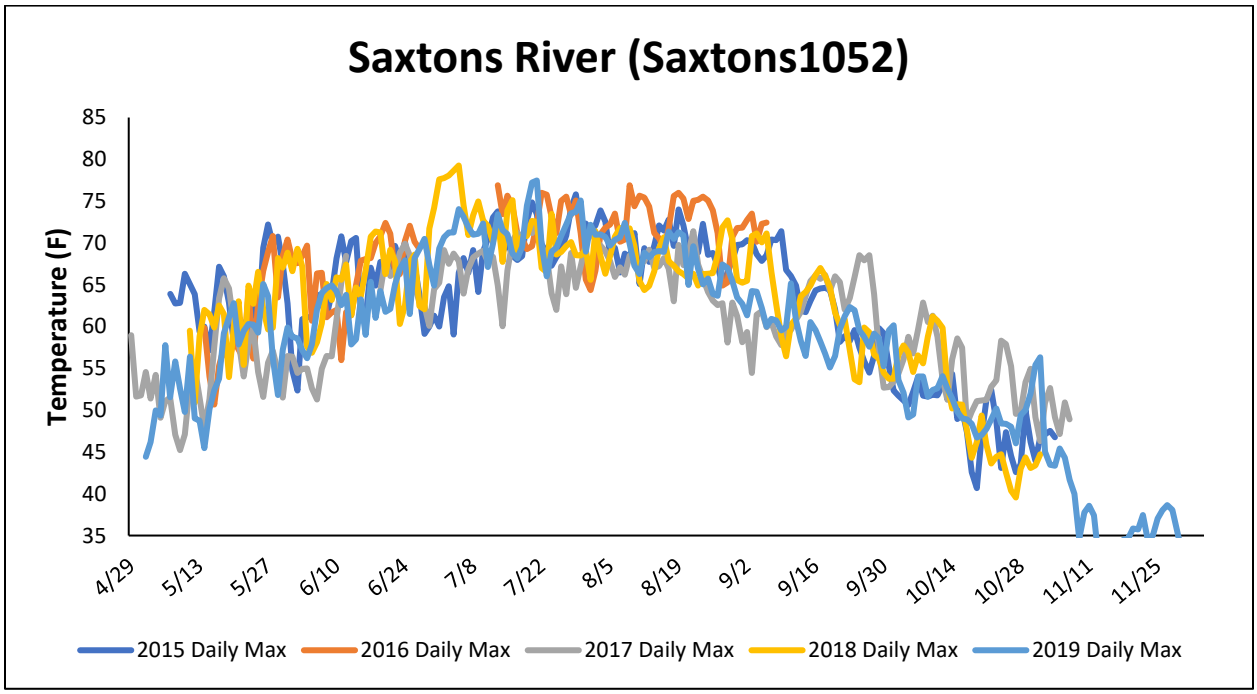


Figure 39. Daily maximum stream temperatures recorded 2015-2019.

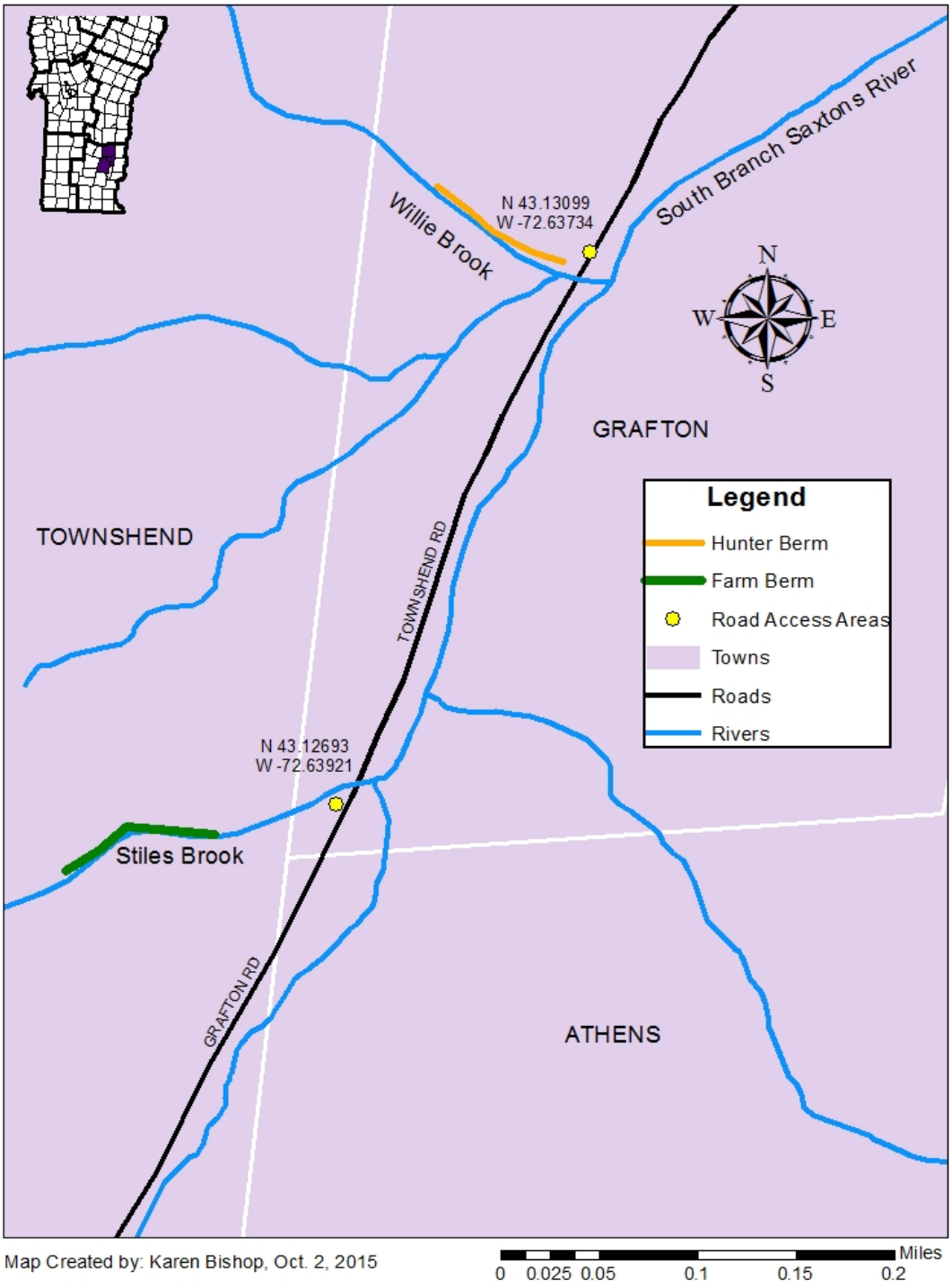


Figure 40. Map of post-Irene berm locations near the South Branch Saxtons.

Figure 41. Photo showing post-Irene berms in the Saxtons watershed. See map for location.

Figure 42. Photo showing post-Irene berms in the Saxtons watershed. See map for location.

Figure 43. Photo showing post-Irene berms in the Saxtons watershed.

Table 1. Species observed in the West River mainstem.	
Common Name	Scientific Name
American eel	*Anguilla rostrata*
Atlantic salmon	*Salmo salar*
Blacknose dace	*Rhinichthys atratulus*
Brook trout	*Salvelinus fontinalis*
Brown bullhead	*Ameiurus nebulosus*
Brown trout	*Salmo trutta*
Common shiner	*Luxilus cornutus*
Creek chub	*Semotilus atromaculatus*
Fallfish	*Semotilus corporalis*
Golden shiner	*Notemigonus crysoleucas*

Longnose dace	*Rhinichthys cataractae*
Mimic shiner	*Notropis volucellus*
Pumpkinseed	*Lepomis gibbosus*
Slimy sculpin	*Cottus cognatus*
Smallmouth bass	*Micropterus dolomieu*
Tessellated darter	*Etheostoma olmstedi*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

Table 2. Water temperature (F) measured at mainstem West River sites.							
Site name	lat	long	Monitoring dates	Mean	Min	Max	Stdev
West1122	43.22744	-72.8135	7/1/1999-10/15/1999	65.64	42.26	84.69	9.21
West1293	43.21915	-72.7944	7/1/1999-10/15/1999	63.4	40.03	82.71	8.35
West256	42.90409	-72.6001	7/28/2000-10/15/2000	61.71	39.47	90.97	7.58
West348	42.95493	-72.6454	7/28/2000-10/15/2000	61.44	43.2	74.53	6.31
West433	43.0346	-72.6691	7/17/1992-10/15/1993	64.37	34.88	87.98	9.61

Table 3. West River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B(1) Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook Trout	All species
Adams Brook	Adams965	42.9493	-72.75736	2013	0	0	739	739
Adams Brook	Adams983	42.9504	-72.758	2013	0	0	0	0
Baker Brook	Baker604	42.9544	-72.69308	2000-2020	0	35	638	649
Ball Mountain Brook	BallMountain1441	43.07388	-72.83642	2000-2020	0	123	373	409
Ball Mountain Brook	BallMountain876	43.09061	-72.79697	2000-2012	0	41	40	65
Cook Brook	Cook1069	43.16594	-72.82319	2007, 2010, 2015	0	0	0	0
Cook Brook	Cook1073	43.1661	-72.82291	2007-2010	0	0	0	0
Cook Brook	Cook1149	43.17925	-72.83572	2004	0	0	18	18
Dover Brook	Dover1600	43.02388	-72.85267	2013	0	0	516	516

Table 3. West River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B(1) Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook Trout	All species
Dover Brook	Dover1659	43.02224	-72.85403	2013	0	0	1743	1743
Fair Brook	Fair610	43.04741	-72.70999	2000-2020	0	0	670	670
Farnum Brook	Farnum1647	43.24258	-72.89429	2018-2019	0	0	634	634
Flood Brook	Flood1315	43.237	-72.85571	2000-2010	0	231	213	444
Grassy Brook	Grassy402	42.98865	-72.62737	2000-2010	0	34	292	299
Grassy Brook	Grassy650	43.04712	-72.59162	2008	0	0	419	419
Greendale Brook	Greendale1560	43.34247	-72.81231	2018-2019	0	0	251	251
Greendale Brook	Greendale1619	43.34435	-72.81268	2000-2017	0	0	789	789
Griffith Brook	Griffith1520	43.28305	-72.88046	2018	0	0	536	536
Hunter Brook	Hunter1033	42.93679	-72.76244	2000-2019	0	17	409	411
Jennycoolidge Brook	Jennycoolidge1580	43.33922	-72.81332	2019	0	0	780	780
Marlboro Brook	Marlboro648	42.93074	-72.70808	2000-2012	0	253	163	416
Marlboro Brook	Marlboro848	42.89803	-72.72023	2000-2012	0	66	261	311
NorthBranchBall Mtn Brook	NorthBranchBall Mtn1108	43.09294	-72.82324	2000-2012	0	67	275	337

Table 3. West River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B(1) Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook Trout	All species
PikeHollow Brook	PikeHollow1627	43.01991	-72.88072	2000-2018	0	78	679	729
Rock River	Rock1250	42.96003	-72.79012	2000-2020	0	0	1340	1340
Rock River	Rock443	42.94813	-72.66609	2000-2010	0	48	48	73
Rock River	Rock690	42.93819	-72.71848	2000-2010	0	46	86	92
Rock River	Rock886	42.94418	-72.75355	2000-2010	0	18	296	299
Smith Brook	Smith443	42.96818	-72.65646	2000-2010	0	218	137	258
Smith Brook	Smith994	43.00399	-72.68993	2000-2010	0	0	477	477
SouthBranchWardsboro	SouthBranchWardsboro1124	43.03212	-72.77713	2000-2020	0	58	563	594
Thompsonburg Brook	Thompsonburg1074	43.19316	-72.79931	2000-2010	0	49	21	61
Tribwest Brook	Tribwest1590	43.29844	-72.80753	2014	0	0	581	581
TurkeyMountain Brook	TurkeyMountain718	43.09024	-72.73338	2000-2010	0	371	180	533
Unnamed Brook	Unnamed1500	43.50434	-72.4354	2016	0	0	1214	1214
Utley Brook	Utley1200	43.24935	-72.82551	2000-2010	0	15	40	44
Utley Brook	Utley1488	43.29232	-72.87984	2000-2017	0	35	661	669

Table 3. West River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B(1) Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook Trout	All species
Utley Brook	Utley1520	43.29272	-72.87995	2019	0	0	200	200
Waite Brook	Waite1328	43.01959	-72.83303	2000-2019	0	21	812	817
Wardsboro Brook	Wardsboro1037	43.03555	-72.79586	2000-2010	0	56	66	121
Wardsboro Brook	Wardsboro1338	43.03276	-72.84734	2000-2018	0	103	499	595
Wardsboro Trib Brook	WardsboroTrib1735	43.00757	-72.80022	2003	0	0	11	11
West River	West1112	43.22726	-72.81395	2001-2010	0	0	11	11
West River	West1289	43.29204	-72.79408	2000-2010	0	20	50	64
West River	West1426	43.32268	-72.7824	2000-2010	0	13	218	220
West River	West771	43.1238	-72.76258	2000-2010	0	15	59	52
West Trib Brook	WestTrib945	43.1267	-72.8008	2008	0	0	321	321
Winhall River	Winhall1074	43.15245	-72.83541	2006-2010	0	11	0	11
Winhall River	Winhall1349	43.14468	-72.89839	2000, 2005, 2007	0	123	132	211
Winhall River	Winhall1401	43.13925	-72.90804	2001, 2002, 2006	0	26	84	101

Table 4. Fish species and number of individuals collected during fish community, creel and bass surveys, Retreat Meadows 2017-2018.

Species	Fish Community	Creel	Bass
American Shad *Alosa sapidissima*	4	0	0
Banded Killifish *Fundulus diaphanus*	32	0	0
Black Crappie *Pomoxis nigromaculatus*	3	176	X*
Bluegill *Lepomis macrochirus*	96	484	X
Brown Bullhead *Ameiurus nebulosus*	0	0	X
Chain Pickerel *Esox niger*	7	80	X
Channel Catfish *Ictalurus punctatus*	0	0	X
Common Carp *Cyprinus carpio*	3	0	X
Golden Shiner *Notemigonus crysoleucas*	2	28	X
Lake Chub *Couesius plumbeus*	3	0	0
Largemouth Bass *Micropterus salmoides*	30	21	48
Northern Pike *Esox lucius*	0	65	X
Pumpkinseed *Lepomis gibbosus*	61	336	X
Rock Bass *Ambloplites rupestris*	2	1	0
Sea Lamprey *Petromyzon marinus*	1	0	X
Smallmouth Bass *Micropterus dolomieu*	0	1	0
unknown centrarchid	60	0	0
Walleye *Stizostedion vitreum vitreum*	0	0	X
White Sucker *Catostomus commersonii*	1	0	X
Yellow Perch *Perca flavescens*	103	434	X
Total individuals	408	1628	48
Species Richness	15	10	14

* - X indicates species presence only

Table 5. Williams River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B1 Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook Trout	All species
Andover Branch	AndoverBranch1230	43.285374	-72.714363	2003, 2014, 2015, 2016	15	416	815	1131
MiddleBranchWilliams	MiddleBranchWilliams730	43.26387	-72.633316	2000-2010	0	70	59	117
MiddleBranchWilliams	MiddleBranchWilliams995	43.261463	-72.690773	2000-2013	0	52	61	85
SouthbranchWilliams	SouthbranchWilliams1329	43.254654	-72.602013	2017- 2020	0	257	201	394
SouthBranchWilliams	SouthBranchWilliams707	43.254654	-72.602013	2000-2016	0	91	87	158
Williams River	Williams1055	43.34547	-72.626106	2016	0	132	752	883
Williams River	Williams520	43.239796	-72.558105	2000-2010	0	15	12	15
Williams River	Williams545	43.254707	-72.57357	2008	0	0	0	0
Williams River	Williams580	43.271538	-72.587944	2000-2010	0	44	40	51
Williams River	Williams695	43.32011	-72.608887	2017	0	0	0	0
WilliamsTrib	WilliamsTrib590	43.236042	-72.539856	2003	0	0	417	417

Table 6. Saxtons River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B1 Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook trout	All species
Bull Creek	BullCreek628	43.12995	-72.56709	2010	0	0	1142	1142
Bull Creek	BullCreek725	43.1088	-72.57298	2010	0	624	1431	2055
Saxtons River	Saxtons1006	43.19815	-72.62494	2012	0	106	634	739
Saxtons River	Saxtons961	43.19232	-72.61665	2012, 2014	0	213	241	455
Saxtons River	Saxtons990	43.19814	-72.62203	2012, 2014	0	171	76	247
Howe Brook	Howe1268	43.15662	-72.64327	2017	0	0	528	528
Leach Brook	Leach570	43.14022	-72.5314	2003, 2006	0	0	113	113

Table 6. Saxtons River Basin trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B1 Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown Trout	Brook trout	All species
Saxtons River	Saxtons1052	43.19662	-72.61913	2015-2020	0	105	79	154
Saxtons River	Saxtons199	43.12429	-72.44016	2017	0	0	0	0
Saxtons River	Saxtons387	43.13167	-72.48116	2000-2010	0	0	45	45
Saxtons River	Saxtons429	43.11843	72.45101	2017	0	0	0	0
Saxtons River	Saxtons452	43.13775	-72.50975	2008	0	0	0	0
Saxtons River	Saxtons492	43.13473	-72.51946	2005, 2006	0	31	60	62
Saxtons River	Saxtons605	43.15225	-72.56221	2006	0	0	0	0
Saxtons River	Saxtons646	43.15697	-72.57292	2000-2010	0	18	33	37
Saxtons River	Saxtons870	43.17726	-72.61257	2006	0	0	25	25
SouthBranchSaxtons Brook	SouthBranchSaxtons859	43.16597	-72.6129	2000-2010	0	94	63	116

Table 7. Connecticut River tributary trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B1 Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown trout	Brook trout	All species
Canoe Brook	Canoe547	42.95914	-72.5588	2016, 2020	0	0	1412	1412
Chase Brook	Chase360	43.015678	-72.461388	2003	0	0	0	0
Chase Brook	Chase541	43.016693	-72.47245	2003, 2004	0	0	0	0
Chase Brook	Chase581	43.020573	-72.477203	2005, 2006	0	0	0	0
Chase Brook	ChaseTrib1300	43.321861	-72.659546	2008	0	0	377	377
Chase Brook	ChaseTrib590	43.020489	-72.478714	2003	0	0	0	0
Crosby Brook	Crosby236	42.880989	-72.554588	2003, 2004	0	0	83	83
Crosby Brook	Crosby255	42.883553	-72.554924	2004	0	0	228	228
Crosby Brook	Crosby272	42.885899	-72.557526	2004	0	0	77	77
Crosby Brook	Crosby302	42.895512	-72.553062	2003, 2004	0	0	831	831
East Putney Brook	EastPutney236	42.985481	-72.470055	2009	356	53	53	462
East Putney Brook	EastPutney284	42.99022	-72.4762	2016	181	155	207	544

Table 7. Connecticut River tributary trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B1 Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown trout	Brook trout	All species
East Putney Brook	EastPutney472	43.006504	-72.490669	2009	0	206	206	412
East Putney Brook	EastPutney705	43.04672	-72.52048	2016-2017	0	204	1670	1874
Mill Brook	Mill360	43.060917	-72.474533	2009	0	0	327	327
Mill Brook	Mill453	43.037609	-72.663063	2000-2010	0	119	562	668
Morse Brook	Morse246	43.093826	-72.444077	2009	60	0	40	100
Morse Brook	Morse429	43.090294	-72.466606	2009, 2020	522	0	1195	1456
Morse Brook	Morse474	43.09039	-72.46674	2017	0	0	1021	1021
Morse Brook	Morse748	43.0896	-72.497101	2009	0	0	1760	1760
Sacketts Brook	Sacketts235	42.972237	-72.518066	2003, 2008	0	38	6	25
Sacketts Brook	Sacketts492	43.00263	-72.53838	2016	0	0	737	737
Salmon Brook	Salmon719	42.94654	-72.57225	2016, 2020	0	0	1417	1417
Sherman Brook	Sherman783	43.426556	-72.488449	2013	0	0	827	827
SouthBranch	SouthBranchCrosby280	42.883808	-72.560471	2004	0	0	225	225

Table 7. Connecticut River tributary trout population data, presented as total trout per mile, collected 2000-2020. For multi-year sampling a mean was taken. Highlight indicates B1 Fishing Criteria met.

Stream Name	Site name	Latitude	Longitude	Sample years	Rainbow trout	Brown trout	Brook trout	All species
Crosby Brook								
SouthBranch Crosby Brook	SouthBranchCrosby312	42.884975	-72.564133	2003	0	0	1003	1003

Appendix E. a. ANR-USACE – Coordination Plan & Partner Agreement

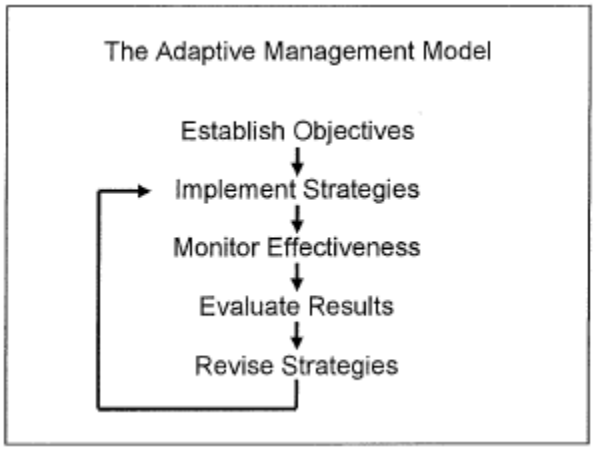
U.S Army Corps of Engineers & Vermont Agency of Natural Resources
Coordination Plan for
Operating Federal Flood Control Dams in Vermont

In recent years, a number of concerns have been raised pertaining to the operation and maintenance of Federal flood control dams in Vermont and across the New England District. To address these concerns, the Vermont Agency of Natural Resources (VANR), U.S. Fish and Wildlife Service (USFWS), and U.S. Army Corps of Engineers (Corps) have engaged in collaborative discussions since 1999 to identify ways to improve operations at the five Corps' flood control projects in Vermont: Union Village, North Hartland, North Springfield, Ball Mountain and Townshend. As a result of these discussions, operational improvements have been enacted, including implementation of conservation flows and ramping standards.

To build on the work performed to date, the three agencies are implementing a three-year adaptive management process (AMP) to use as a framework for identifying and resolving issues of concern. The goal of the process is to evaluate current operational and maintenance practices and identify ways to maintain and restore the integrity of the downstream and upstream aquatic and terrestrial ecosystems while maintaining the projects' primary purpose of flood control and recognizing other recreation and natural resource management objectives.

The Adaptive Management Process

A basic tenet of adaptive management involves continued monitoring and evaluation leading to revised strategies that will achieve the desired results (see figure). This approach allows the participants to address problems and areas of uncertainty over time. In this case, issues related to the operation, maintenance and modification of the flood control projects will be addressed.



Each of the three participating agencies will designate representatives to a working group that will implement this plan. Other participants will be called in as needed to provide their expertise on specific issues.

A key part of the process is the annual interagency coordination meeting, to be held in January of each year. This meeting will provide the agencies with an opportunity to review the previous years' operations, revise operational and monitoring procedures, and raise new issues. Other meetings or site visits will be held as needed.

A number of issues identified and discussed in this plan require resolution or effectiveness monitoring. Adaptive management relies upon the collection of data that can be used to make appropriate adjustments. Assessment plans (for monitoring/assessment/evaluation) will be developed for each pending issue so that participating agencies have the information needed to move forward at each annual meeting.

Responsibility for administering the adaptive management process will rotate among the three agencies on an annual basis. The U.S. Fish and Wildlife Service will take the lead in the first year, followed by the Vermont Agency

of Natural Resources, and then the U.S. Army Corps of Engineers. Administrative duties include organizing meetings (scheduling, preparing agendas, preparing meeting notes) and site visits. Each agency will be responsible for suggesting meeting agenda topics and preparing any necessary background material. Any modifications or operational changes agreed to by the parties will be incorporated into the operating and maintenance policies and practices of each project.

The Adaptive Management Plan

Regulation of flood control dams involves both flood control and non-flood control operations. In general, flood control operations involve the coordinated regulation of dams located on tributaries to reduce flood damages downstream of the dam and to reduce flood damages collectively on the Connecticut River. Flood control operations are authorized by Congress and implemented by the reservoir regulation manual for projects in the Upper Connecticut River Basin.

Non-flood control operations describe the scheduled or recurring regulation of the dams for other purposes. Flood control projects in Vermont are authorized to perform natural resources management activities and provide public recreational opportunities. A hydropower facility was added to North Hartland Dam at a later date.

Objectives:

- Maintain the dams' flood control function while mitigating the ecological impacts of flood control operations.
- During non-flood control periods, maintain downstream flows as close to instantaneous run-of-river as feasible, with outflow equal to inflow.

The following sections discuss a number of issues related to dam operation and identify those that will be addressed in the adaptive management process.

Flood Control Operations:

The Corps has maintained that it is necessary to maintain maximum operational flexibility during flood control periods. However, VANR and USFWS have expressed concerns about the ecological impacts of flood control operations. While the Corps has implemented ramping and conservation flow standards, the VANR and USFWS do not consider those standards protective of downstream resources and have advocated that more information be provided on how more protective standards would affect flood control capabilities.

Both ANR and USFWS have expressed an interest in learning when the projects are in flood control operations. The Corps will provide background information on how these decisions are made. Rather than try to define theoretically what may constitute flood operations at the dams, the Corps prefers to find a reliable way to contact and notify ANR and USFWS and incorporate this into the Communication Procedures.

Conservation flow, ramping, and reservoir release/refill standards for flood control operations will be addressed during the adaptive management period.

Routine Operations:

The Corps, ANR, and USFWS have agreed to the concept of routinely operating the dams in instantaneous run-of-river mode (outflow equal to inflow) outside of flood control periods. Differences remain on how closely releases from the dams should equal inflow. These differences are most evident at North Hartland and Ball Mountain, where pools are maintained year-round and outflow is controlled by the gate openings. It is also an issue, to a lesser extent, at Union Village, which has a pool in the winter only. VANR has identified problematic flow fluctuations and instances where flows fall below ABF during routine operations at these projects.

Over a 3-year period, the Corps will increase flow monitoring and gate adjustment frequency to twice a day during the work week and on the weekends if necessary, at Union Village (winter only), North Hartland, and Ball Mountain. Further, the parties will review the procedures used to monitor and adjust gate settings and develop procedures to improve routine daily flow management. The objective of this exercise is to develop procedures that will maintain outflow equal to inflow to the greatest extent feasible.

Non-Flood Control Operations:

While the general goal is run-of-river operation, the parties have identified circumstances, outside of flood control operations, when flow or reservoir stage manipulation is necessary or appropriate. Those circumstances are listed below and described in more detail in subsequent sections.

1. Whitewater boating releases
2. Periodic inspections
3. Beach maintenance
4. Major maintenance and rehabilitation
5. Emergency operations

As noted in the detailed descriptions, there is not consensus among the parties regarding when flow or stage manipulation is necessary.

During such periods, the Corps will employ conservation flow, ramping, and reservoir refill standards that serve to protect the ecological integrity of the downstream reach.

With respect to conservation flows, the Corps has implemented the USFWS Aquatic Base Flow (ABF) standard for non-flood control operations at all projects. The ABF standard is based on the drainage area at the dam and is expressed in cfs/mile or csm. The rates vary seasonally:

October – March: 1.0 csm (or inflow)
April – May: 4.0 csm (or inflow)
June – September: 0.5 csm (or inflow)

The Corps has agreed to maintain the seasonal ABF flow at all times when flows are being manipulated (i.e., non run-of-river) outside of flood control operations, provided inflows are equal or greater than ABF.

Similarly, ramping rates have been adopted at all projects for use during all operations (including routine) outside of flood control periods. The ramping rates are 0.5 csm/hr for flows up to 4.0 csm, and 1.0 csm/hr for flows greater than 4.0 csm.

Reservoir water level management is the final water management issue. Reservoir refill standards have been implemented by the Corps. When refilling the reservoir or raising the reservoir to an increased target level during non-flood periods, the seasonal ABF will be maintained at all times except when flows are below ABF. If inflows are less than ABF, then a 70/30 rule will be implemented whereby the dam will pass at least 70 percent of inflow while storing no more than 30 percent.

The Agency of Natural Resources contends that the 70/30 rule does not provide adequate protection for downstream resources, and has proposed a 90/10 rule, with 90 percent of inflow being released downstream. Resolution of this issue will be a priority of the adaptive management process.

During the AMP, a clear statement of seasonal reservoir target elevations will be developed. Other issues related to reservoir water level management will be identified by the parties within the first year of the adaptive management process and addressed.

Whitewater boating releases

The Corps has provided releases to accommodate scheduled recreational boating events at many of its dams for over forty years. At present there are two whitewater release events scheduled at Ball Mountain Dam and Townshend Lake. These releases, which are timed to coincide with planned seasonal regulations of the conservation pool, are scheduled for the last weekend in April and again in late September. In recent years, the resource agencies have raised concerns about the ecological impacts of these releases. In response, beginning in 2003, the Corps adopted the minimum conservation flows and ramping rates recommended by the U.S. Fish and Wildlife Service for each project.

For the spring release on the West River, the Corps will follow the ANR/USFWS ramping and refill rates agreed to by the parties. In addition, an overnight flow of 4.0 csm will be maintained. The target pool elevation at the start of this release will be approximately 75 feet with a target pool elevation of 25 feet at the end. Releases beyond the last weekend in April will not be considered due to the need to pass salmon smolts downstream in the spring.

For the fall release on the West River, the Corps will follow the ANR/USFWS ramping and refill rates agreed to by the parties. Beginning in 2003, the Corps has released water to support a one-day event. A full two-day event may be possible under conditions when where there is sufficient inflow to support a second day while employing ramping and 4.0 csm flows overnight. The target pool elevation at the start of this release will be 65 feet with a target pool elevation of 35 feet at the end.

Periodic inspections

To assure the integrity and ability of a flood control dam to perform its authorized purposes, inspection of the entire dam and related structures is performed every five years. Periodic inspection is required for the continued operation of the dam. In the future, the Corps will perform conduit and outlet works and gate inspections without restricting outflows from the control structures if and when possible. During these inspections, the flood control gates must be operated for structural, mechanical and electrical performance. Minor fluctuations to the outflow could be encountered during periodic inspection; however, testing of flood control gates will generally not occur during low-flow periods.

The preferred time to conduct conduit inspections will be during low-flow periods when this can be completed without interrupting river flows. The Corps will attempt to perform conduit inspections both prior to and during the scheduled fiscal year of the periodic inspection. If this is not feasible, some reduction of river flows may still be required in order to conduct a satisfactory inspection. Periodic inspections of dams in Vermont are scheduled as follows:

2002 – North Springfield Lake, Townshend Lake
2003 – None
2004 – Ball Mountain Dam, North Hartland Lake, Union Village Dam
2005 – None
2006 – None
2007 – North Springfield Lake, Townshend Lake

The following monitoring and operational procedures will be performed to minimize impacts during the inspection event:

If the outlet works and conduit can be safely inspected without disruption of flow during low-flow periods, the periodic inspection, and/or the inspection of the conduit/flood control gates, will be conducted at that time. To increase the probability of being able to perform conduit inspections during low-flow periods, the Corps will conduct inspections, if possible, whenever these naturally occur.

If reductions of flow are necessary to perform conduit inspections, outflow will be reduced only to the extent needed to safely inspect the conduit (historically < 1 hour). Under extenuating circumstances, the inspections may take longer to complete. Prior to and during each conduit/flood control gate inspection, the Corps will have biologists evaluate the impact of any planned gate operation on the upstream and downstream communities and habitat. During any shutdown, biologists will be stationed downstream of the conduit to monitor river conditions and rescue stranded fauna. These monitoring activities and protocols will be coordinated with the VANR and USFWS. In 2002, monitoring protocols for performing conduit inspections were developed and implemented at North Springfield Lake. Further refinement of periodic inspection and monitoring procedures are a high-priority for the AMP.

Beach Maintenance

The Corps maintains public swimming beaches in Vermont at North Hartland Lake, Townshend Lake and at Stoughton Pond at North Springfield Lake. These beaches are maintained annually to inspect the public swimming area and to remove debris and sedimentation that collects on the beach over the winter and when flood storage events inundate the beach and swimming area. The Corps will attempt to perform maintenance of the public swimming beaches without drawing down the conservation pool. As
part of this AMP, the parties will develop a process to determine if a satisfactory and safe facility can be maintained without water level manipulation.

The Corps has prepared a draft beach maintenance SOP that addresses issues surrounding the timing and mechanics of performing beach maintenance to minimize impacts to both downstream and reservoir aquatic habitats and species. VANR and USFWS will review the SOP and provide suggestions and alternatives for maintenance activities. Upon review and finalization, the beach maintenance SOP will be submitted to the agency representatives for their review and concurrence.

Major Maintenance and Rehabilitation:

Major maintenance and rehabilitation of the dams and appurtenant structures are necessary for their continued operation. These are large-scale projects, so they will be planned and coordinated separately from other routine or recurring activities. Close coordination with VANR and USFWS will begin early in the planning process and continue through project completion.

Emergency Operations:

Occasionally, the Corps will need to operate the dams in response to unplanned emergencies. These emergencies include acts of God, casualties, disasters, national defense or homeland security emergencies. At these times it may become necessary to take immediate steps to contain, limit, or alleviate an emergency in order to protect human health, safety, and welfare prior to initiating any form of coordination or consultation with other agencies or individuals. In these instances, the Corps will contact VANR and USFWS, among others, as soon as practicable, if emergency modification or interruption of flows has occurred.

Fish Migration and Passage:

Ball Mountain Dam and Townshend Lake have been modified to allow for passage of Atlantic salmon. The facilities at Ball Mountain Dam consist of one automated gate and at Townshend Dam a modified weir to allow for outmigration of salmon smolts. A trap-and-truck facility was constructed at Townshend Lake in 1993 to allow migrating adults to be trapped from the West River below Townshend Dam and transported above Townshend Lake and Ball Mountain Dam to locations identified by Vermont Fish and Wildlife. In 2002, the trap-and-truck facility at Townshend Lake was upgraded to a variable array electric barrier that was designed, constructed and operated in a manner that has significantly reduced gate operations and minimizes impacts to the downstream aquatic habitat. North Springfield Lake also has a modified outlet pool to protect salmon smolts.

Project Modifications:

The Corps recognizes a need to study the performance of the outlet works at Union Village Dam, North Hartland Lake and Ball Mountain Dam. At these projects, the Corps ability to maintain permanent or seasonal conservation pools, as well as maintaining run-of-river conditions, without a weir or static flow control structure is difficult. Another related issue is the repair or modification of the outlet gates at Townshend Lake.

In 1995, the Corps prepared a sedimentation study for Ball Mountain Dam that identifies and evaluates structural alternatives to the project. The study addressed the prevention of unplanned silt discharges into the West River resulting from faulty gate operations or failure of the automated gate operators.

The Corps recognizes the need for further study to identify and implement structural changes to the Vermont flood control dams to alleviate flow regulation problems and enhance the aquatic habitat. Any future study to modify these dams would need to be conducted under existing authorities. If current authorities are not workable, the agency representatives will pursue other funding or authorities. As part of the adaptive management process, the Corps will investigate water temperature problems at North Springfield and Townshend Lakes to address potential warm water invasion created by shallow conservation pools and top-spilling weirs. The Corps Water Quality Team is available to prepare study parameters and provide an alternative analysis of possible solutions.

The agencies have prioritized their respective needs. The agencies will jointly prioritize the respective priorities and propose a plan to implement studies or improvements.

- Vermont Agency of Natural Resources priorities:
  - Flow regulation improvement at Ball Mountain
  - Flow regulation improvement at North Hartland
  - Winter flow regulation improvement at Union Village
  - Downstream temperature impacts at Townshend
  - Downstream temperature impacts at North Springfield

- U. S. Fish and Wildlife Service priorities:
  - Feasibility studies of weirs at all gate-operated projects
  - Feasibility studies of converting projects with conservation pools to dry bed systems

- Corps of Engineers priorities:
  - Feasibility of weirs at Ball Mountain and N. Hartland Lake
  - Instream flow study on West River downstream of Ball Mountain Dam
  - Instream flow study on Black River downstream of N. Springfield Dam
  - Instream flow study on Ompompanoosuc River downstream of Union Village Dam

Coordination:

The following agency representatives should continue to serve in the capacity of moderators for meetings and dispute resolution. This Adaptive Management Plan and attachments will prevail unless amended and agreed to by all agencies. All parties involved in the preparation, implementation and evaluation of this plan agree to present their recommendations to these representatives for resolution or implementation prior to elevating their concerns to other persons, offices or agencies.

Supervisor, New England Field Office
U.S. Fish and Wildlife Service

7/22/04
Date

Acting Director, Water Quality Division
Department of Environmental Conservation
Vermont Agency of Natural Resources

7/22/04
Date

Chief, Construction/Operations Division
New England District
U.S. Army Corps of Engineers

7/22/04
Date

Appendix E. b. ANR-USACE –Partnering Agreement

US Army Corps of Engineers®
New England District

U.S. ARMY CORPS OF ENGINEERS
&
VERMONT AGENCY OF NATURAL RESOURCES

PARTNERING AGREEMENT

WHEREAS, the United States Army Corps of Engineers (Corps) and the Vermont Agency of Natural Resources are committed to working together in a spirit of cooperation, mutual respect, and trust for the purpose of bringing to the public a new standard of excellence in management of Vermont's natural resources; and WHEREAS the Corps and the State of Vermont share jurisdiction over activities that affect Vermont's natural resources; and WHEREAS the Corps operates several flood control dams in the State of Vermont and the careful maintenance and operation of these dams is important to the protection and preservation of Vermont's natural resources; and WHEREAS the Corps and the State of Vermont recognize their mutual obligation to fully comply with State and Federal environmental laws and requirements (including, but not limited to the federal Clean Water Act, Vermont Water Quality Standards, water quality certifications, and permits); and WHEREAS the Corps and the State of Vermont hereby commit to improving communications and cooperation between them to assure that the Corps' regulatory programs and the Corps' operation and maintenance of flood control dams fully comply with State and Federal environmental laws and requirements,

NOW, THEREFORE, the Corps of Engineers and the Vermont Agency of Natural Resources AGREE that:

1. *The Corps and the State of Vermont hereby commit to:*
   - a. *Establish and maintain clear lines of honest, open and timely communications;*
   - b. *Establish and maintain a clear understanding of each other's roles, responsibilities and processes;*
   - c. *Resolve issues at the lowest appropriate level;*
   - d. *Be responsive to each other in a timely manner;*
   - e. *Work together at the earliest possible stage to address regulatory and project issues;*
   - f. *Where appropriate, jointly develop projects to improve the environment, and develop solutions to environmental problems; and*
   - g. *Jointly develop and maintain action plans to implement this paragraph.*
2. *The Corps will continue to refine and improve its management systems to assure compliance with Vermont's environmental laws and requirements.*
3. *The Corps' employees, agents and contractors commit to fully comply with Vermont's environmental laws and requirements. Any violation or attempt to violate or otherwise subvert Vermont's environmental laws and requirements shall be grounds for considering disciplinary action.*
4. *The Corps, its employees, agents and contractors shall immediately cease any activity that causes any violation of Vermont's environmental laws and requirements. The Corps shall direct its employees, agents and contractors to immediately, upon discovery or notice that an activity is causing any violation of Vermont's environmental laws or requirements, to immediately: (a) cease such activity, and (b) consult with appropriate State personnel.*
5. *The Corps commits to take all actions requisite to accepting and maintaining gifts of land on the West River as proposed in correspondence between the Corps and the Vermont Land Trust (including a letter dated October 9, 1998 from Gil Livingston to Dick Carlson).*

Appendix E. c. - VDFW - Assessment of the 2019 USACE whitewater release effects on aquatic resources of the West River

State of Vermont *Agency of Natural Resources*
Fish & Wildlife Department
100 Mineral Street, Suite 302 [cell] 802-777-0827
Springfield, VT 05156-3168 [fax] 802-885-8890
www.vtfishandwildlife.com [email] lael.will@vermont.gov

Memorandum

TO: The File

FROM: Pete McHugh and Lael Will, Fisheries Biologists

DATE: September 23, 2019

SUBJECT: Assessment of the 2019 USACE whitewater release effects on aquatic resources of the West River.

Recreational whitewater releases can severely alter natural river flow and thus have the potential to adversely affect aquatic organisms and their habitats. Seasonal (spring, fall) releases from the U.S. Army Corps of Engineers' (USACE) Ball Mountain Dam on the West River have been a long-standing subject of concern for the Agency of Natural Resources (ANR), one which led to the establishment of a 1998 partnering agreement that committed the parties to '…*recognize their mutual obligation to fully comply with State and Federal environmental laws and requirements*…' and meet routinely to devise a flow-management scheme that fulfilled this goal. This collaborative process led the adoption of numerical guidance[50] in 2004 that would shape recreational flows for the ensuing decade.

In 2014, USACE proposed new operational guidance[51] that aimed to increase the hydrologic feasibility of holding a two-day whitewater release during the water-limited fall. Within the same timeframe, the Atlantic Salmon Restoration Program ended and new information regarding Species of Greatest Conservation Need became available for the West River. The Agency did not concur with the proposal and therefore requested that the parties meet to evaluate the feasibility of finding a mutually agreeable operating condition (VT DEC 2014). However, the Corps adopted whitewater operations (ramping, overnight flows) consistent

[50] The agreed-to operating protocol includes the following provisions: up-/down-ramping at a rate of 170 cfs per hour when flows exceed 690 cfs and 90 cfs/hour when flows are below this level; and overnight flows (i.e., between Saturday's and Sunday's releases) of 690 cfs.

[51] The operating provisions proposed in 2014 include: up-/down -ramping at a rate of 340 cfs per hour when flows exceed 690 cfs and 170 cfs/hour when flows are below this level; and overnight flows equivalent to reservoir inflows.

with their 2014 proposal. They have been operating under this scenario since 2014 despite several attempts from the Agency to discuss concerns and alternative operational scenarios that would adequately protect aquatic resources.

In October of 2018, ANR staff met with USACE to briefly discuss the West River and concerns relating to flow alterations. We agreed to set a meeting in the Spring of 2019 to discuss flow-related concerns and potentially come to an agreement. This meeting never occurred.

The West River is home to two imperiled (state listed as threatened or endangered) mussels, the brook floater (*Alasmidonta varicosa*) and the eastern pearlshell mussel (*Margaritifera margaritifera*), and Species of Greatest Conservation Need (SGCN) including brook trout (*Salvelinus fontinalis)* and sea lamprey (*Petromyzon marinus*). Since these scheduled white-water events have the potential to adversely affect riverine organisms during a period of otherwise low flows (late September), we aimed at assessing and documenting the physical and biological impacts of the autumn recreational release.

Specifically, during the September 21-22, 2019 event, we evaluated if/whether an event of the typical scheduled release's magnitude (~1,600 cfs) adversely affects eastern pearlshell mussels and/or their habitat (i.e., through bed scour, erosion and deposition, etc.) using a simple pre- vs. post-event comparison approach.

In order to evaluate the impacts to riverine fishes including mortality, and stranding, we conducted a nighttime survey during the evening of September 21, 2019 to capture the low-flow period between the two events.

Our primary objectives were to:

(1) *Determine whether a two-day scheduled whitewater event, comprised of two back-to-back days of high flows causes any observable displacement (~losses) or mortality of eastern pearlshell mussels*. We did this by locating mussel beds before (on Sept. 19) and after (on Sept 23) the whitewater event and documenting the presence/absence of individual live mussels in several focal areas. For this effort, we focused on areas demonstrated to contain either or both eastern pearlshell or brook floater in a prior assessment of the mussel communities of the West River (i.e., sites no. 2 [in Jamaica State Park, ~1/4 mi upstream from trailhead] and no. 10 [at VT-30/100 bridge] in Nedeau 2014[52])

(2) *Assess the extent to which the shear stress imparted on the stream bed by the event causes scour or fill in mussel-inhabited areas of the river (i.e., mussel beds), a potentially important mechanism of impact to individuals or habitats*. We did this by

[52] Nedeau, E. 2014. Brook Floater (*Alasmidonta varicosa*) in the West River in Vermont.

deploying 'tracer particles' (i.e., painted cobbles[53]) in and around mussel beds and relocating them after the event occurred. Additionally, we assessed the potential for scour by continuously recording (15 min interval) the change in hydraulics, principally depth, within a subset of mussel beds throughout the event using water level loggers. Flow variation was also monitored below Townshend Dam, to see the extent to which that reservoir might attenuate the event's flow and confine the scope of impact to the reach between Ball Mountain Dam and Townshend Pool.

(3) *Evaluate the impacts to riverine fishes including mortality, and stranding*. We did this by conducting a reconnaissance survey prior to the event to identify point locations that we could safely access the river to observe the shoreline and areas that had been subsequently dewatered. A total of 11 sites were identified and marked prior to the survey (Figure 5). On the night after the first release event, which coincided with the low-flow period, we walked the shoreline at those point locations and documented any dead or stranded fish (Figure 5). Of note is that the survey area was very limited in scope and was intended to obtain a sample from which to document impacts. To fully evaluate the extent of impacts the sample area and associated impacts should be extrapolated out to the total impacted area.

Key Findings & Observations

Operations & Hydraulics

- Operations generally proceeded according to the operations proposed by the US Army Corps of Engineers in 2014 rather than the agreed-upon operations embodied in the interagency agreement from 2004[5].
- As in the last three years, the event consisted of two successive releases reaching an approximately 1,600 cfs magnitude peak with a return to ~inflows for the overnight condition (**Figure 1**). Because the West River's natural flows were generally low heading into the event weekend (20-30 cfs), this means that increased and decreased by a factor of ~60 twice during a ~48-hour period.
- Up- and down-ramping of flows between successive releases ranged 200-400 cfs per hour, a rate double than the 2004 agreement.
- Depths increased by 2-3 feet at all of the locations that were monitored over the course of the event (**Figure 1**).

[53] Measured particle size: median (d50) = 80 mm, mean = 83 mm, SD = 8 mm (CV 10%)

- There was little evidence of event attenuation at Townshend Dam, suggesting that the impoundment provides no attenuation when it adheres to its run-of-river license condition (i.e., outside of flood control).

Mussel & Tracer Particle Observations

- All of the mussels that were located and marked (i.e., with tracer particles) prior to the event were relocated afterwards and deemed to be alive (i.e., upright with inhalant and exhalent vents open), and there were no obvious signs of an impact to adult mussels from the event (Figure 2). It should be noted, however, that because observations were limited to lager/older, well-established eastern pearlshell mussels, it remains unknown whether the whitewater event has impacts on smaller or younger individuals or species (e.g., brook floater, which are more prevalent below Townshend Dam). Moreover, sample size was relatively small.
- None of the tracer particles exhibited signs of noteworthy movement. However, algae and biofilms were clearly scoured and there was evidence of fine sediment erosion and deposition (Figure 3).
- During the post-event survey, which was mussel focused primarily, a single dead longnose dace was recovered (Figure 5). This, combined with observations of stranding in an overnight survey conducted by Springfield District staff, suggests that direct mortality of fish was a direct result of the event.

Fish Stranding and Mortality

During the hours of 22:00 and 01:00 on the night of September 21, we surveyed a total of nine sites downstream of the Ball Mountain Dam (Figure 6). The survey began at West River site 1 and ended at the “Dumplings”. The Dumplings site is located in between sites 8 and 9 and is not shown on the map. The two lowermost sites (West River site 9-10) were not surveyed. Surveying occurred by walking the river-left shoreline for approximately 300-400 feet at each site. A crew of three people visually observed and documented any species that were either stranded and dead, or stranded and alive (in isolated pools). Any species that were dead were brought back to the lab for positive identification. West River Site 1 was associated with a mid-channel bar (Figure 6). Surveying occurred along the entire circumference of the bar. Four stranded and dead lake chub (*Couesius plumbeus*) were found at the upper portion of the mid-channel bar (Figure 7). West River sites 6 and 7 contained bluegill, brown bullhead, and young-of year trout trapped in isolated pools.

Considering flows cycled from 28 cfs to 1640 cfs, we estimated that approximately two-thirds of the wetted width was dewatered during the event (Figure 8). This occurred twice during a 48-hour period. Survey areas were fairly limited in scope considering the amount of habitat that was impacted by the event. Therefore, while it may seem that impacts to aquatic biota are negligible, extrapolating this out to the entire river results in substantial impacts.

Pursuant to ***§ 4606. Taking fish by unlawful means***

(a) A person shall not take fish by means of explosives, or use explosives in any waters or have the same in his possession upon any waters, the shores thereof or islands therein, except for mining or mechanical purposes.

(b) A person shall not place in any waters lime, creosote, coculus inducus, or other drug or poison destructive to fish.

(c) A person shall not take or kill fish by shutting or drawing off water.

The operations of the USACE to accommodate these recreational releases is in violation of this statute. Moreover, the Agency has repeatedly tried to engage the Corps in discussions surrounding the management of flows in the West River. This memo serves to provide clear documentation on impacts surrounding these white-water releases with the goal of engaging the Corps and improving conditions for aquatic biota in the West River.

Next Steps and Management Recommendations:

- Utilize this information to engage the Corps in discussions regarding their departure from our Partnering Agreement.
- Consider focusing on documenting the effects of the event on mussels (e.g., at brook floater sites), stranding, and habitat/hydraulics in the river below Townshend Dam, and perhaps also trying to determine how far downstream event effects propagate.
- Continue focusing efforts on documenting and quantifying fish stranding impacts. Given that we have documented mortality by investigating a small portion of the total river length affected by the event, it is quite likely that total event-related mortality scales to a relatively large number. Future efforts should obtain estimates on the total area influenced by the event to fully account for the magnitude of mortality and stranding.

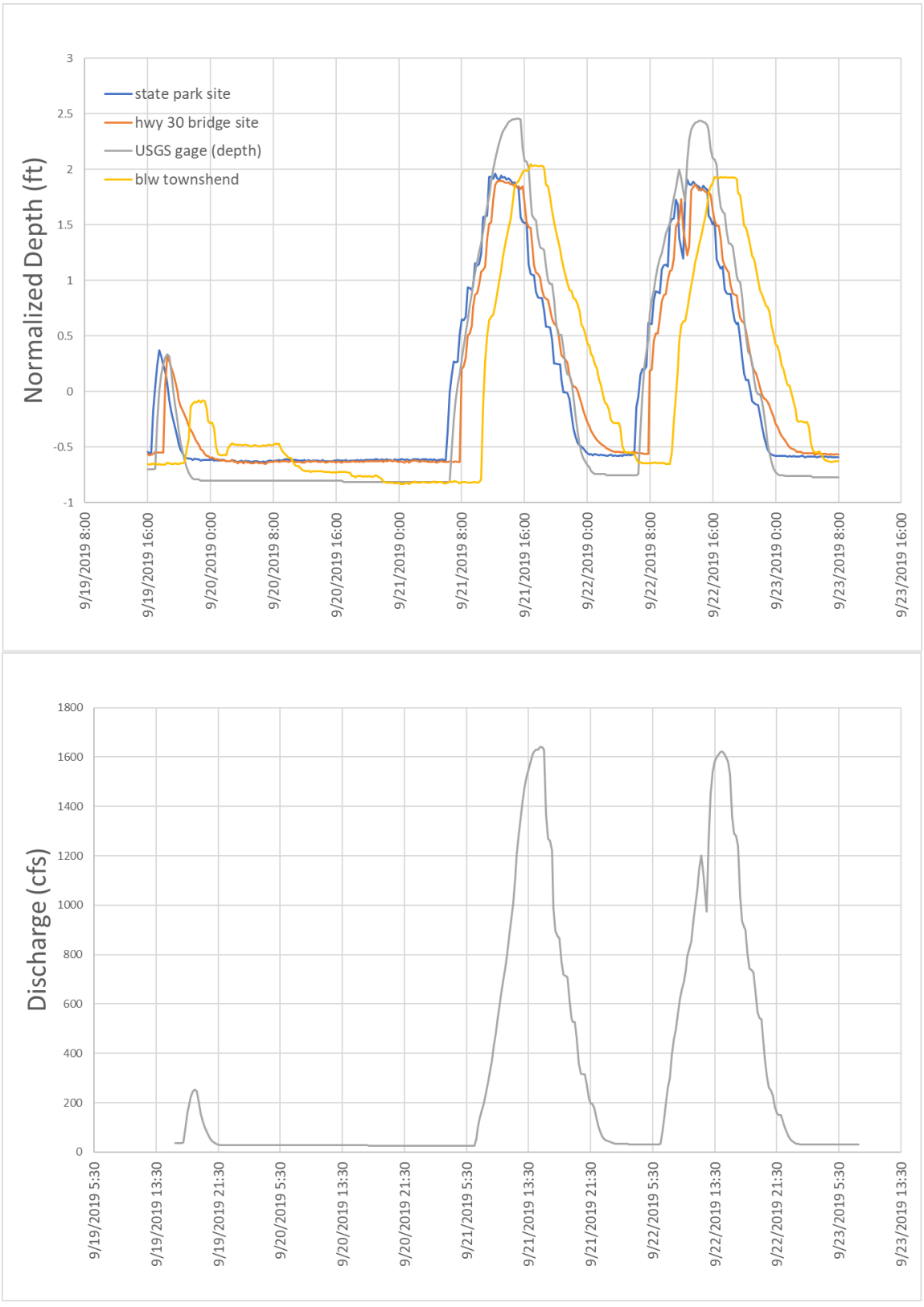


Figure 1. Flows and water levels measured at sites monitored during the 2019 event.

Figure 2. Example of eastern pearlshell mussel and tracer particles located before and after the fall 2019 whitewater event. Note that while both aufwuchs and fine sediment were scoured significantly, neither the mussels nor the tracer particles were dislodged or mobilized.

Figure 3. Examples of eastern pearlshell mussel and tracer particles located before and after the fall 2019 whitewater event. Note that while both aufwuchs and fine sediment were scoured significantly, neither the mussels nor the tracer particles were dislodged or mobilized.

Figure 4. Observation of a dead longnose dace recovered in the post-event mussel survey; although the cause of mortality cannot be conclusively determined, it is likely event-related given concurrent, related observations of stranding documented by Springfield District staff.

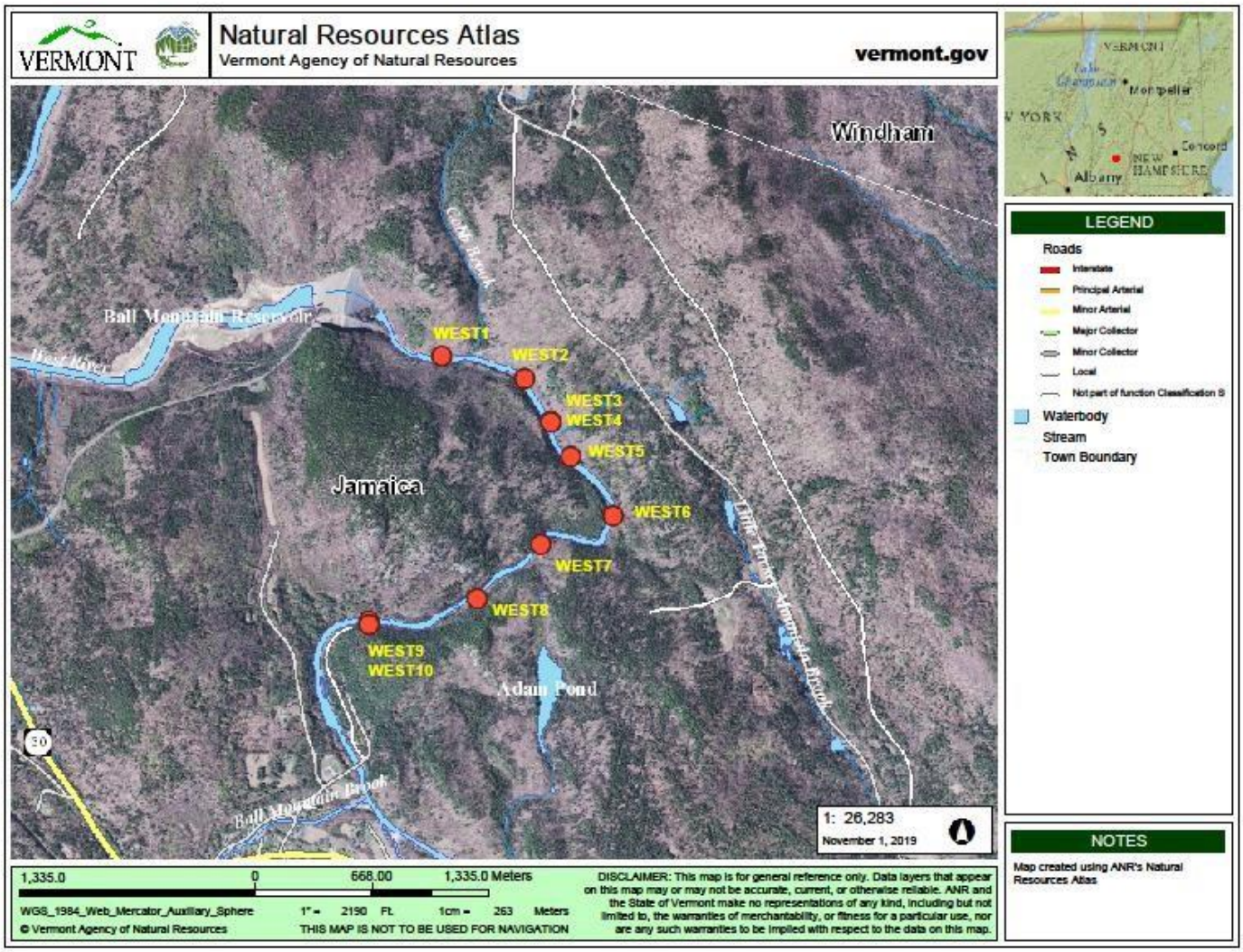


Figure 5. Site locations of the West River stranding survey, September 21-22, 2019.

Figure 6. Location of West River Site 1 showing mid-channel bar.

Figure 7. Stranded lake chub located at the West River Site 1.

Figure 8. Example of dewatered area and characteristics of sites where the survey was conducted.

Appendix F. Municipal Water Quality Protectiveness Matrix

Town	National Flood Insurance Program	Road and Bridge Standards	Emergency Management Plan (LEMP)	Hazard Mitigation Plan (LHMP)	River Corridor Protection	ERAF	Flood Resilience in Town Plan	Stormwater Mapping	Illicit Discharge Detection and Elimination	Storm-water Master Plan
Status→	Enrolled	Adopted	Completed	Adopted	Adopted	Percent	Completed	Completed	Completed	Completed
Brattleboro	Yes	Yes	Yes	Yes	Yes	17.50%	Yes	No	Yes	No
Marlboro	Yes	Yes	Yes	Yes	Yes	17.50%	Plan Expired	Yes	Current Study	No
Putney	Yes	Yes	Yes	Yes	Yes	17.50%	Yes	Yes	Current Study	No
Windham	Yes	Yes	Yes	Yes	Interim	17.50%	Yes	No	No	No
Winhall	Yes	Yes	Yes	Yes	Interim	17.50%	Yes	Yes	Current Study	No
Andover	Yes	Yes	Yes	Yes	No	12.50%	Yes	No	No	No
Brookline	Yes	Yes	Yes	Yes	No	12.50%	Yes	No	No	No
Chester	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Dover	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Dummerston	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Grafton	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Ludlow	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Yes	Yes
Newfane	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Town	**National Flood**	**Road and Bridge Standards**	**Emergency Management Plan (LEMP)**	**Hazard Mitigation**	**River Corridor Protection**	**ERAF**	**Flood Resilience**	**Stormwater Mapping**	**Illicit Discharge Detection**	**Storm-water**

	Insurance Program			Plan (LHMP)			in Town Plan		and Elimination	Master Plan
Status→	Enrolled	Adopted	Completed	Adopted	Adopted	Percent	Completed	Completed	Completed	Completed
Springfield	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Yes	Yes
Stratton	Yes	Yes	Yes	Yes	No	12.50%	Plan Expired	Yes	No	No
Townshend	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Westminster	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Weston	Yes	Yes	Yes	Yes	No	12.50%	Yes	Yes	Current Study	No
Athens	No	Yes	Yes	Yes	No	7.50%	No Plan	No	No	No
Cavendish	Yes	Yes	No	Yes	Yes	7.50%	Yes	Yes	Yes	No
Jamaica	Yes	Yes	Yes	No	No	7.50%	Yes	Yes	Current Study	No
Landgrove	Yes	No	Yes	Yes	Yes	7.50%	Yes	Yes	No	No
Londonderry	Yes	Yes	Yes	No	No	7.50%	Yes	Yes	Current Study	No
Mount Holly	Yes	Yes	Yes	No	No	7.50%	Yes	Yes	Yes	No
Mount Tabor	No	No	Yes	No	No	7.50%	Plan Expired	No	No	No
Peru	Yes	No	Yes	No	No	7.50%	Yes	Yes	No	No
Rockingham	Yes	No	Yes	No	No	7.50%	Yes	Yes	Current Study	No
Sunderland	Yes	Yes	Yes	No	Yes	7.50%	Yes	Yes	No	Yes
Wardsboro	Yes	No	Yes	Yes	No	7.50%	Yes	Yes	Current Study	No

Appendix G. Regional Plan Conformance

Mount Ascutney
Regional Commission

May 24, 2021

Peter Walke, Commissioner
Vermont Department of Environmental Conservation
1 National Life Drive
Montpelier, Vermont 05620

Subject: **Recommendations regarding conformance of the Draft West, Williams and Saxtons Tactical Basin Plan with the 2018 Southern Windsor County Regional Plan pursuant to 10 V.S.A. § 1253(d)**

Dear Commissioner Walke,

The Mount Ascutney Regional Commission (MARC), formerly the Southern Windsor County Regional Planning Commission (SWCRPC), would like to commend the Department of Environmental Conservation (DEC) Watershed Planning Program, and specifically Basin Planner Marie Caduto, on the comprehensive analysis contained in the draft *West, Williams and Saxtons Rivers & Lower Connecticut River Tactical Basin Plan* (Basin 11 Plan). We appreciate the opportunity to work with Marie and other DEC staff to strengthen municipal, regional and public participation in the Tactical Basin Planning process.

The MARC is highly supportive of and active in the planning process for the protection and improvement of surface and groundwater resources throughout southern Windsor County. We consider Tactical Basin Planning to be integral in that process. The MARC works with our member municipalities to develop, adopt and implement policies that achieve water quality protection and improvement, and have used prior iterations of the Basin 11 Plan innumerable times to do so. We are eager to continue cooperating with DEC on the development and implementation of Tactical Basin Plans in the future.

Background
MARC is granted the opportunity to provide recommendations to the Agency of Natural Resources (ANR) regarding the development of Tactical Basin Plans pursuant to the following section of Vermont Statutes Title 10, Chapter 47 § 1253(d).

- (2)(I) … *the Secretary* [of Natural Resources] *shall: develop, in consultation with the regional planning commissions, an analysis and formal recommendation on conformance with the goals and objectives of applicable regional plans.*

The West, Williams and Saxtons drainage basin includes only a small portion of MARC's region, encompassing a majority of the Towns of Andover and Chester, and a small corner of the south-west portion of Springfield.

The MARC reviewed the draft Basin 11 Plan that was issued in March, 2021. The purpose of this letter is to analyze the relative conformance of the draft *West, Williams and Saxtons Rivers and Lower Connecticut River Tactical Basin Plan* with the relevant goals and objectives of the *2018 Southern Windsor County Regional Plan*.

Conformance with the Regional Plan

The draft *West, Williams and Saxtons Rivers and Lower Connecticut River Tactical Basin Plan* is supportive of the *2018 Southern Windsor County Regional Plan*, specifically with the following Goals and Objectives of the Regional Plan. The table below demonstrates a number of instances in which the Basin 11 Plan's top strategies are in conformance with and supportive of the applicable Goals and Objectives of the Regional Plan.

CONFORMANCE ANALYSIS	
Draft Basin 11 Plan, Priority Strategies and Recommendations	**Conformance with Goals, Recommendations and Policies of the 2018 Southern Windsor County Regional Plan**
Implement wetland restoration as sites and opportunities are identified.	Wetland restoration and protection is listed as a priority throughout the Regional Plan. Wetlands are identified in the Plan as beneficial to community flood resilience, as well as stormwater attenuation and treatment, wildlife habitat, water quality, aesthetics and recreation. Wetland identification, protection and preservation is listed as a top Water Resources Goal on page 98 of the Regional Plan.
Increase the number of river and floodplain restoration projects to re-establish connections to floodplains.	It is a Policy of the Regional Plan to encourage the protection and active restoration of mapped floodplain areas in an effort to promote flood resilient communities (page 100). In addition, the Regional Plan prohibits the construction of new berms that would restrict a rivers' access to adjacent floodplains (page 100).
Conduct stormwater master planning to identify and prioritize actions and implement High Priority projects.	Stormwater master planning supports numerous Goals, Objectives and Policies of the Regional Plan. A top Water Resources Goal listed on page 98 is to improve and maintain water quality. It is well established that proper management and treatment of stormwater runoff from developed lands (a key component of stormwater master planning) is critical to improving and protecting surface water quality. Proper treatment of stormwater runoff is essential in mitigating sediment and nutrient loading, as well as discharge of toxic substances from impervious surfaces (gasoline, coolant, pet waste, etc.). In addition, proper stormwater management can help mitigate stormwater inputs to natural watercourses, helping to alleviate peak flood elevations, serving the dual purpose of improving water quality and aiding in promotion of flood resilient communities, which is listed as another key objective of the Regional Plan (pages 99, 100).
Remove dams; especially High Hazard dams.	Dams are listed in the Regional Plan as detrimental to aquatic passage (free upstream and downstream movement) for fish and other aquatic species. Dam failure (such as failure of a High Hazard dam) is listed as a causal agent for exacerbated flooding and fluvial erosion. In addition, dams are well known to adversely impact water quality and aquatic habitat. Therefore, removal of High Hazard or obsolete dams aligns well with the Goals and Objectives of the Regional Plan to protect and improve water quality (page 98), limit wildlife habitat degradation (pages 97, 98), and promote flood resilient communities (pages 99, 100).
Work with municipalities to adopt floodplain and river corridor protections to achieve greater ERAF funding levels.	Municipal adoption of floodplain and river corridor protections aligns with Water Resources Policy 5 (page 99) of the Regional Plan, in which development in mapped floodways, floodplains, and river corridors is discouraged. In addition, adoption of flood hazard area protections aligns with the recommendations of the Emergency Management element of the Regional Plan, in which adoption of municipal regulations to promote resilience in the event of a declared disaster (such as flooding) in encouraged (page 66).

Work with municipalities to complete Hazard Mitigation Plans and Emergency Management Plans.	Hazard mitigation planning is listed in the Regional Plan as one of the four primary objectives of the discipline of Emergency Management Planning, along with preparedness, response and recovery. The Regional Plan clarifies that adoption of a FEMA-approved Hazard Mitigation Plan is essential for maintaining eligibility for FEMA-administered hazard mitigation funds. Municipal eligibility for hazard mitigation funding is key to implementing the Regional Plan's Policy to promote flood resilient communities (page 99). In addition, consideration is given to region-wide emergency management and response planning as a Policy in the Regional Plan.
Implement road stormwater and roadside erosion control practices that prevent erosion and treat road-related sources of pollution.	It is a Policy of the Regional Plan to promote adoption of minimum standards for town roads, bridges and culverts, such as adoption of the VTrans model Town Highway Road and Bridge Standards (page 65). The model standards include basic road erosion control practices (stone-lining roadside ditches, installation of drainage culverts, proper vegetative cover along road drainage networks) that help to prevent road erosion and treat road-related pollution sources. These practices also help to promote flood and climate change resilience, further aligning with numerous Goals and Objectives of the Regional Plan.

Plan Conformance Conclusion

Given the nature and relatively narrow focus of Tactical Basin Plans, there are a number of Goals and Objectives of the Regional Plan that are not necessarily actively supported by the draft Basin 11 Plan, such as sufficient and equitable access to public education and affordable housing, among other issues. However, this is to be expected. There are no apparent conflicts between the Goals and Objectives of the two Plans, and a majority of the strategies listed in the draft Basin 11 Plan are actively supportive of the applicable Goals and Objectives of the 2018 Regional Plan. The draft *West, Williams and Saxtons Rivers and Lower Connecticut River Tactical Basin Plan* is in conformance with and supportive of the applicable Goals and Objectives of the *2018 Southern Windsor County Regional Plan*.

We appreciate the opportunity to provide feedback on the draft Basin 11 Tactical Basin Plan. We look forward to working with the Department of Environmental Conservation to implement the Plan over the next five years. Should you have any questions or desire clarification on the contents of this letter, please do not hesitate to contact Chris Yurek at cyurek@marcvt.org or 802-674-9201, ext. 119.

Thank you for your consideration.

Sincerely,

Thomas Kennedy

Thomas Kennedy, AICP
Executive Director

CC: MARC Board of Commissioners (by electronic submission)
Marie Levesque Caduto, DEC Basin Planner (by electronic submission)
Chris Yurek, MARC Planner (by electronic submission)

Appendix H. Responsiveness Summary